Appendix I

PHABSIM Site and Transect Photographs

Instream Flow Study

Lower Tuolumne River
Basso Bridge Reach

July 24, 2011, September 24, 2011, & June 26, 2012

R. Liebig, K. Jarrett, I. Pryor, W. Swaney, S. Araya, K. Orr, N. Jurjavcic, R. McLintock, H. Bowen, M. Reymann, and K. Rodriguez

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP0001

Medium Flow- 250 CFS- Benchmark 1 Setup September 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

IMGP0003

Medium Flow- 250 CFS- Ken Jarrett at Benchmark 1

September 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

IMGP0004

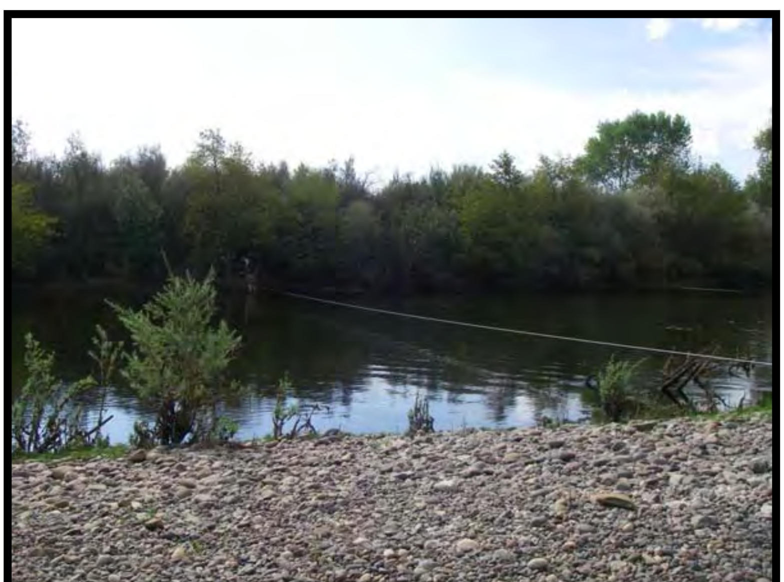
Medium Flow- 250 CFS- Benchmark 4 on River Left from Upstream

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 24A-
Looking Downstream from River Right
IMGP0767
June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



Medium Flow- 250 CFS- Transect 24A
Looking Downstream from River Right
IMGP0005
September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP6265

High Flow- 600 CFS- Transect 24A- Looking Downstream from River Right

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP0768

Low Flow- 100 CFS- Transect 24A- Looking Upstream from River Right

June 26, 2012

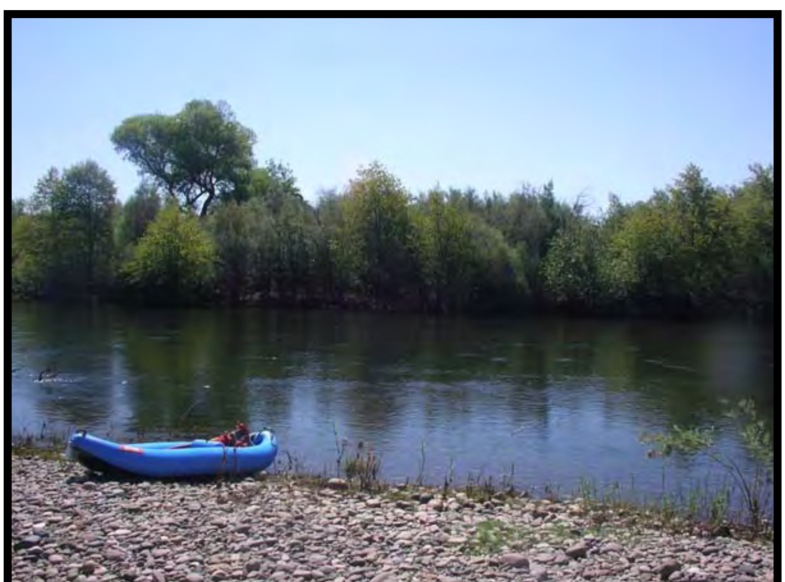
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP0006

Medium Flow- 250 CFS- Transect 24A
Looking Upstream from River Right

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



IMGP6266

High Flow- 600 CFS- Transect 24A-
Looking Upstream from River Right

July 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

Low Flow- 100 CFS- Transect 24A- Looking Across from River Right

IMGP0766

June 26, 2012

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

Medium Flow- 250 CFS- Transect 24A- Looking Across from River Right

IMGP0010

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 24A- Looking Across from River Right IMGP6264 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 24B- Looking Across from River Right IMGP0764 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 24B- Looking Across from River Right IMGP0007 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 24B- Looking Across from River Right IMGP6267 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 24B- Looking Downstream from River Right IMGP0765 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 24B- Looking Downstream from River Right IMGP0008 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 24B-
Looking Downstream from River Right
IMGP6268
July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 24B-
Looking Upstream from River Right
IMGP0763
June 26, 2012

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

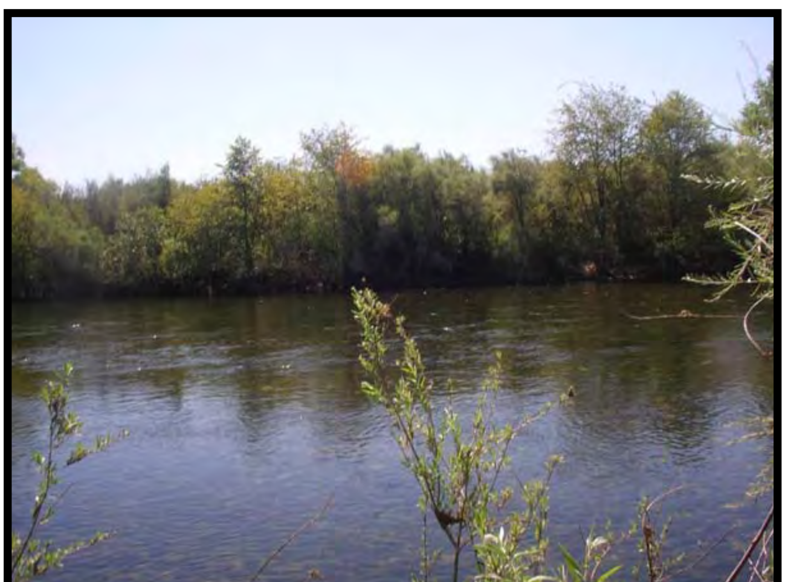
Medium Flow- 250 CFS- Transect 24B-
Looking Upstream from River Right

IMGP0009

September 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach



High Flow- 600 CFS- Transect 24B-
Looking Upstream from River Right

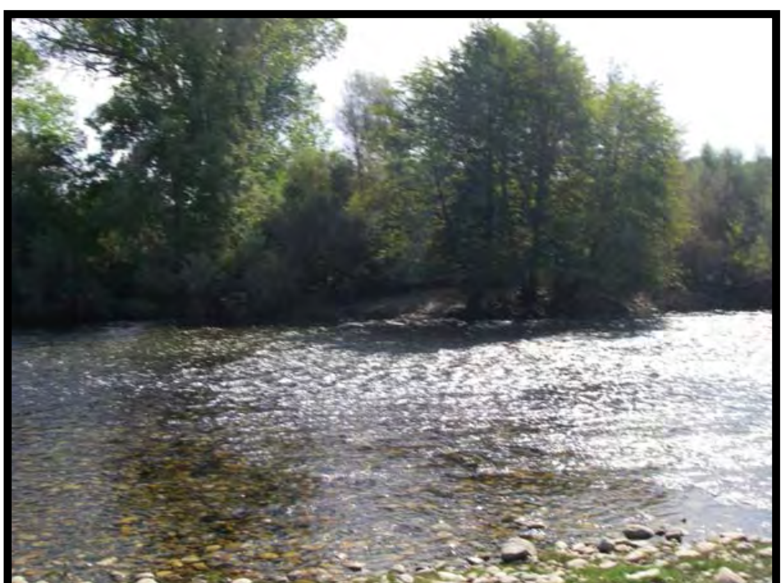
IMGP6269

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 25A- Looking Across from River Right IMGP0761 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



Medium Flow- 250 CFS- Transect 25A- Looking Across from River Right IMGP0011 September 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

High Flow- 600 CFS- Transect 25A- Looking Across from River Right

IMGP6270

July 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

Low Flow- 100 CFS- Transect 25A- Looking Downstream from River Right

IMGP0762

June 26, 2012

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

Medium Flow- 250 CFS- Transect 25A- Looking Downstream from River Right

IMGP0012

September 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

High Flow- 600 CFS- Transect 25A- Looking Downstream from River Right

IMGP6271

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 25A- Looking Upstream from River Right IMGP0760 June 26, 2012

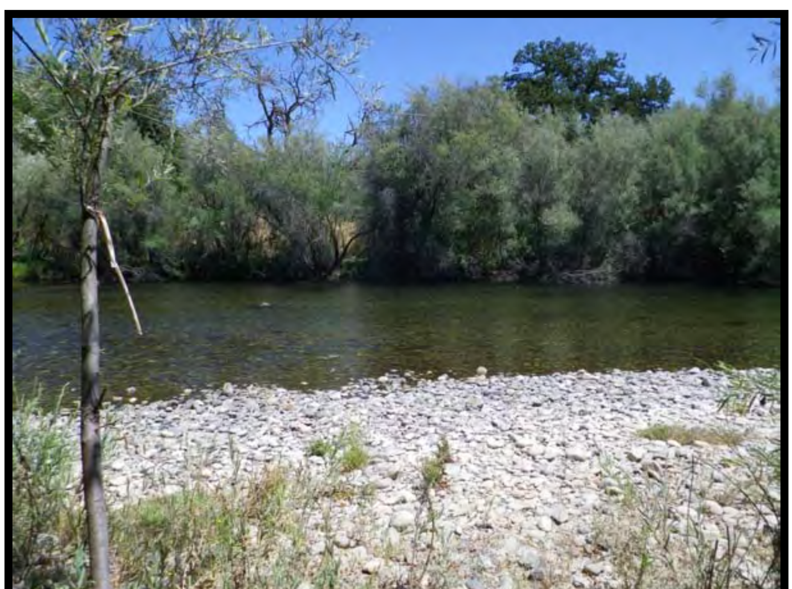
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 25A- Looking Upstream from River Right IMGP0013 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 25A-
Looking Upstream from River Right
IMGP6273
July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

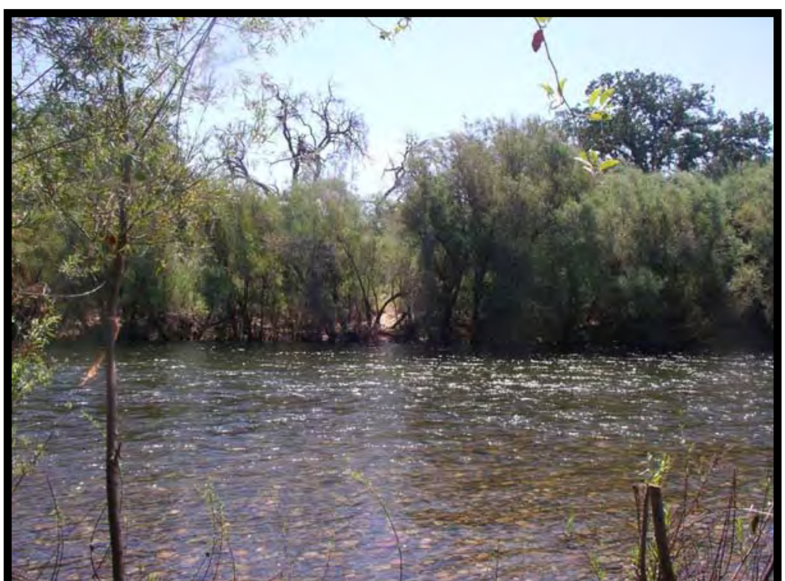


Low Flow- 100 CFS- Transect 25B-
Looking Across from River Right
IMGP0758
June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 25B- Looking Across from River Right IMGP0014 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



High Flow- 600 CFS- Transect 25B- Looking Across from River Right IMGP6274 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 25B- Looking Downstream from River Right IMGP0759 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 25B- Looking Downstream from River Right IMGP0015 September 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

High Flow- 600 CFS- Transect 25B- Looking Downstream from River Right

IMGP6275

July 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

Low Flow- 100 CFS- Transect 25B- Looking Upstream from River Right

IMGP0757

June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 25B- Looking Upstream from River Right IMGP0016 September 24, 2011

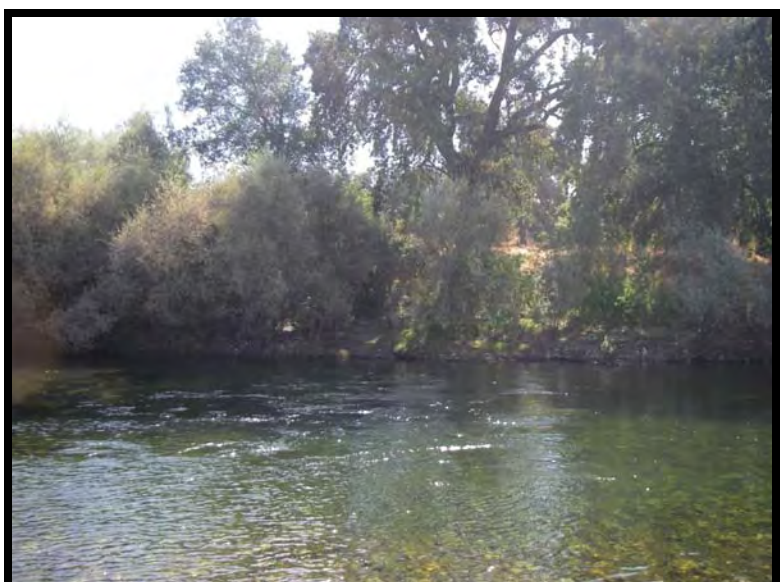
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 25B- Looking Upstream from River Right IMGP6276 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 26A-
Looking Across from River Right IMGP0755 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



Medium Flow- 250 CFS- Transect 26A-
Looking Across from River Right IMGP0017 September 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

High Flow- 600 CFS- Transect 26A-
Looking Across from River Right

IMGP6277

July 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

Low Flow- 100 CFS- Transect 26A-
Looking Downstream from River Right

IMGP0756

June 26, 2012

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

Medium Flow- 250 CFS- Transect 26A-
Looking Downstream from River Right

IMGP0018

September 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

High Flow- 600 CFS- Transect 26A-
Looking Downstream from River Right

IMGP6278

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 26A- Looking Upstream from River Right IMGP0754 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 26A- Looking Upstream from River Right IMGP0019 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 26A- Looking Upstream from River Right IMGP6279 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 26B- Looking Across from River Right IMGP0747 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 26B- Looking Across from River Right IMGP0020 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 26B- Looking Across from River Right IMGP6280 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 26B- Looking Downstream from River Right IMGP0748 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 26B- Looking Downstream from River Right IMGP0021 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 26B- Looking Downstream from River Right IMGP6281 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 26B- Looking Upstream from River Right IMGP0746 June 26, 2012

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

Medium Flow- 250 CFS- Transect 26B-
Looking Upstream from River Right

IMGP0022

September 24, 2011

Lower Tuolumne River Instream Flow Study

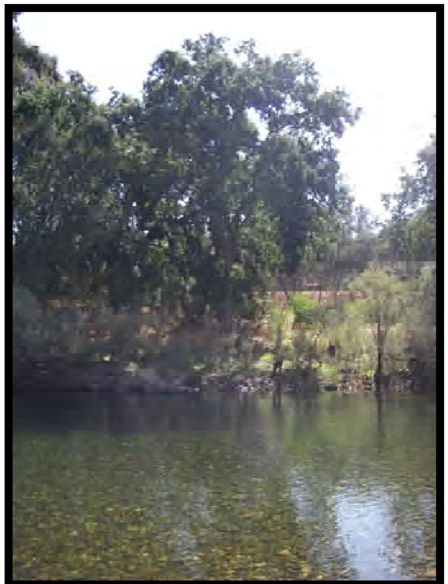
Basso Bridge Reach

High Flow- 600 CFS- Transect 26B-
Looking Upstream from River Right

IMGP6282

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



IMGP0023

Medium Flow- 250 CFS- Benchmark 3 from Across, River Right September 24, 2011

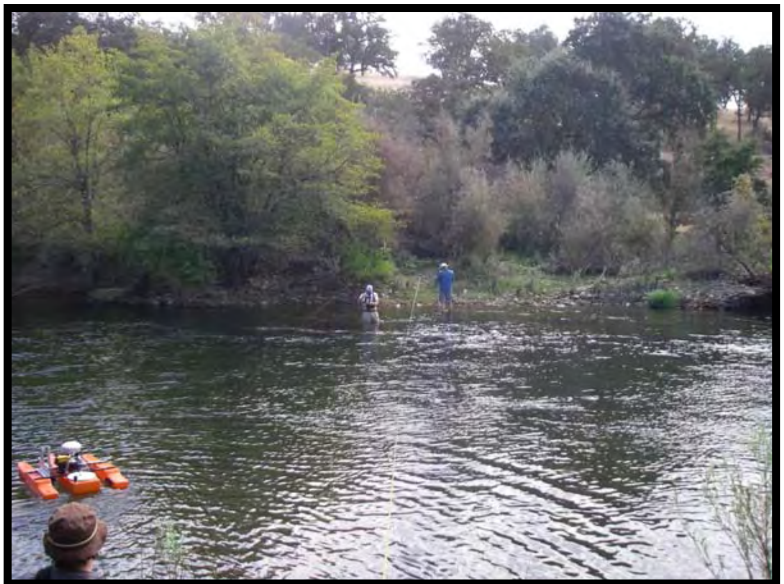
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP0744

Low Flow- 100 CFS- Transect 28A- Looking Across from River Right June 26, 2012

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach



Medium Flow- 250 CFS- Transect 28A- Looking Across from River Right

IMGP0024

September 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

High Flow- 600 CFS- Transect 28A- Looking Across from River Right

IMGP6283

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 28A-
Looking Downstream from River Right
IMGP0745
June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 28A-
Looking Downstream from River Right
IMGP0027
September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 28A- Looking Downstream from River Right IMGP6284 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 26B- Looking Upstream from River Right IMGP0746 June 26, 2012

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach

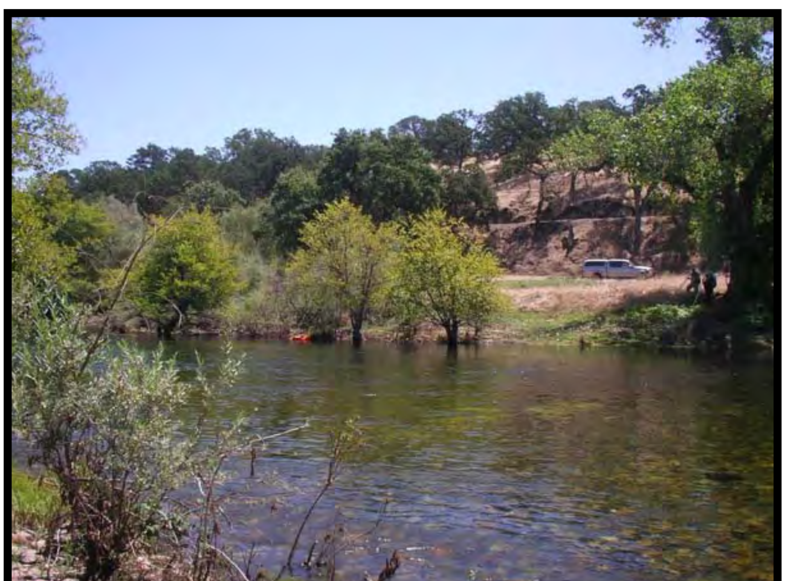
Medium Flow- 250 CFS- Transect 28A- Looking Upstream from River Right

IMGP0029

September 24, 2011

Lower Tuolumne River Instream Flow Study

Basso Bridge Reach



High Flow- 600 CFS- Transect 28A- Looking Upstream from River Right

IMGP6286

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 28B- Looking Downstream from Head Pin for 28A River Right IMGP0743 June 26, 2012

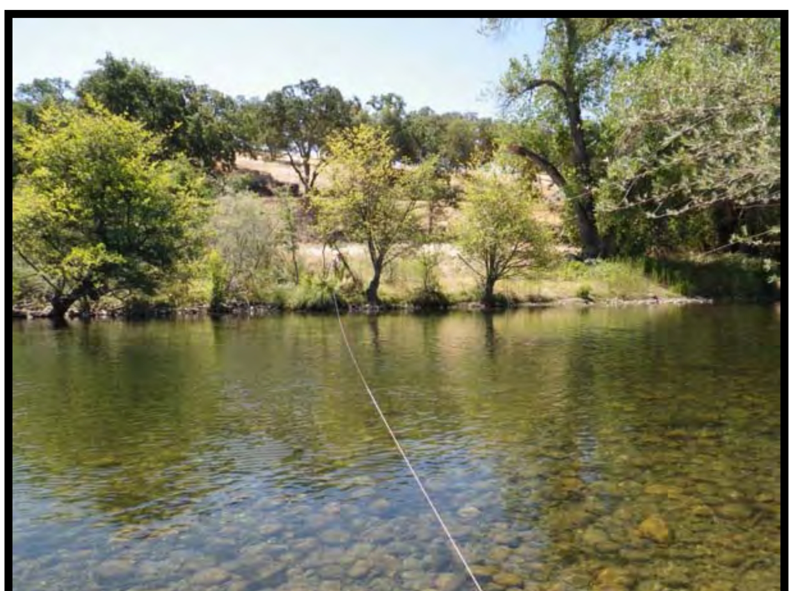
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 28B- Looking Downstream from River Right IMGP0028 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 28B-
Looking Downstream from River Right IMGP6285 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



Low Flow- 100 CFS- Transect 28B-
Looking Across from River Right IMGP0740 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 28B- Looking Across from River Right IMGP0030 September 24, 2011

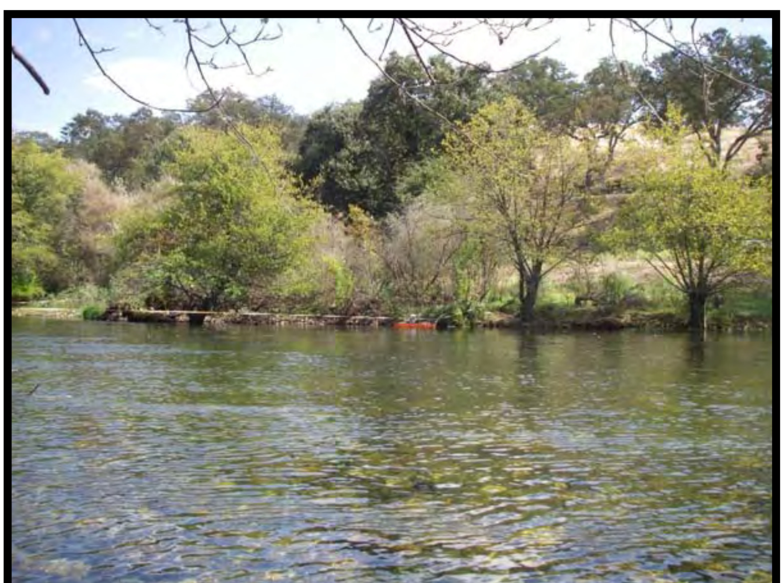
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 28B- Looking Across from River Right IMGP6287 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 28B- Looking Upstream from River Right IMGP0741 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



Medium Flow- 250 CFS- Transect 28B- Looking Upstream from River Right IMGP0031 September 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

High Flow- 600 CFS- Transect 28B- Looking Upstream from River Right IMGP6288 July 24, 2011

Lower Tuolumne River Instream Flow Study | Basso Bridge Reach

Low Flow- 100 CFS- Transect 29A- Looking Across from River Right IMGP0738 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 29A- Looking Across from River Right
IMGP0032
*29A was not photographed at 600 CFS
September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 29A- Looking Downstream from River Right
IMGP0739
June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 29A- Looking Downstream from River Right

IMGP0033

* Transect 29A was not photographed at 600 CFS

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 29A- Looking Upstream from River Right

IMGP0737

June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP0034

Medium Flow- 250 CFS- Transect 29A- Looking Upstream from River Right

*29A was not photographed at 600 CFS

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

IMGP0735

Low Flow- 100 CFS- Transect 30A- Looking Across from River Left

June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 30A- Looking Across from River Left

IMGP0035

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 30A- Looking Across from River Left

IMGP6289

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 30A- Looking Downstream from River Left IMGP0736 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 30A- Looking Downstream from River Left IMGP0036 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 30A-
Looking Downstream from River Left IMGP6290 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 30A-
Looking Upstream from River Left IMGP0734 June 26, 2012

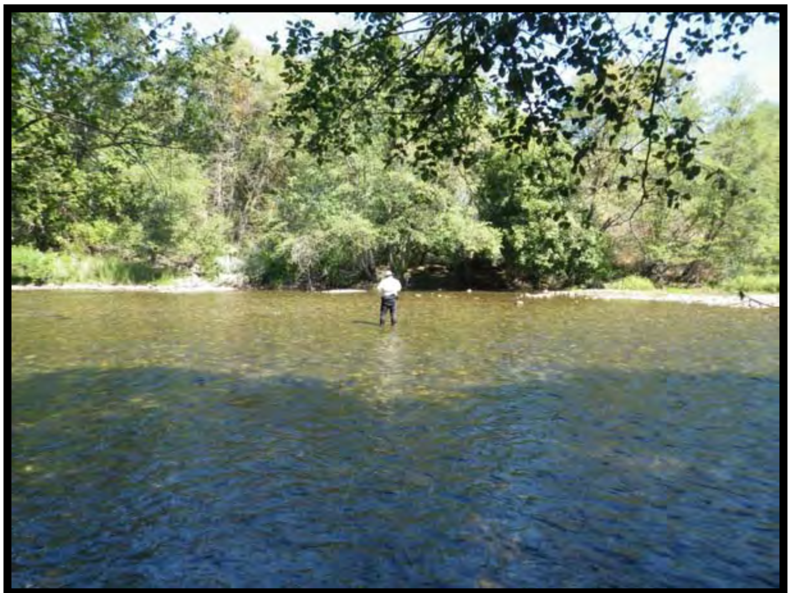
Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 30A- Looking Upstream from River Left IMGP0037 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 30A- Looking Upstream from River Left IMGP6291 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



Low Flow- 100 CFS- Transect 30B-
Looking Across from Tail Pin River Left

IMGP0732

June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 30B-
Looking Across from River Left

IMGP0038

September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 30B-
Looking Across from River Left

IMGP6293

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 30B-
Looking Upstream from River Left

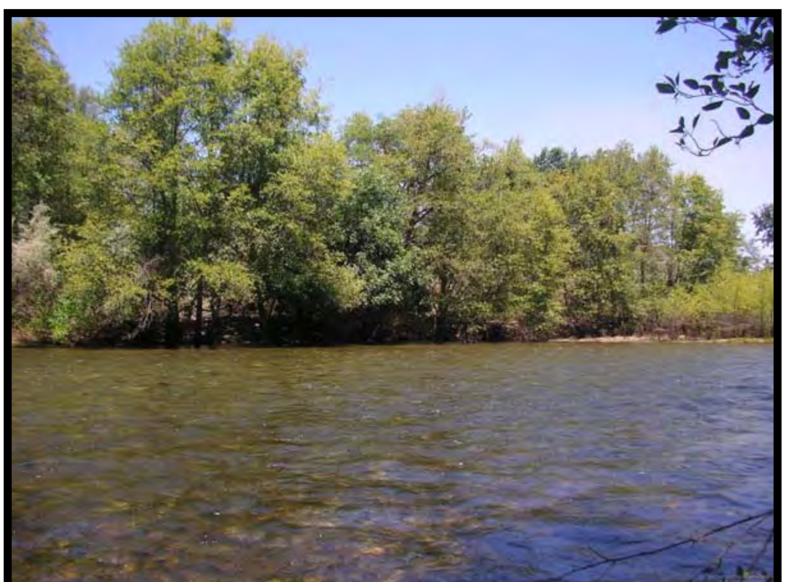
IMGP0731

June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 30B- Looking Upstream from River Left IMGP0039 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach



High Flow- 600 CFS- Transect 30B- Looking Upstream from River Left IMGP6294 July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Low Flow- 100 CFS- Transect 30B- Looking Downstream from River Left IMGP0733 June 26, 2012

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Transect 30B- Looking Downstream from River Left IMGP0041 September 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

High Flow- 600 CFS- Transect 30B- Looking Downstream from River Left

IMGP6292

July 24, 2011

Lower Tuolumne River Instream Flow Study Basso Bridge Reach

Medium Flow- 250 CFS- Benchmark 1 at Base of Oak

IMGP0040

September 24, 2011

Instream Flow Study

Lower Tuolumne River
Bobcat Flat Reach

July 25, 2011, September 25, 2011,
& June 27, 2012

R. Liebig, K. Jarrett, I. Pryor, W. Swaney, S. Araya, K. Orr, N. Jurjavcic, R. McLintock, H. Bowen, M. Reymann, and K. Rodriguez

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0042

Mid Flow- 250 CFS- Transect 82A- Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6295

High Flow- 600 CFS- Transect 82A-
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0043

Mid Flow- 250 CFS- Transect 82A-
Looking Downstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6296

High Flow- 600 CFS- Transect 82A-
Looking Downstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0044

Mid Flow- 250 CFS- Transect 82A-
Looking Upstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6297

High Flow- 600 CFS- Transect 82A-
Looking Upstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0045

Mid Flow- 250 CFS- Transect 82B-
Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 82B-
Looking Across from River Right

IMGP6298

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 82B-
Looking Downstream from River Right

IMGP0046

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6299

High Flow- 600 CFS- Transect 82B-
Looking Downstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0047

Mid Flow- 250 CFS- Transect 82B-
Looking Upstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6300

High Flow- 600 CFS- Transect 82B- Looking Upstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

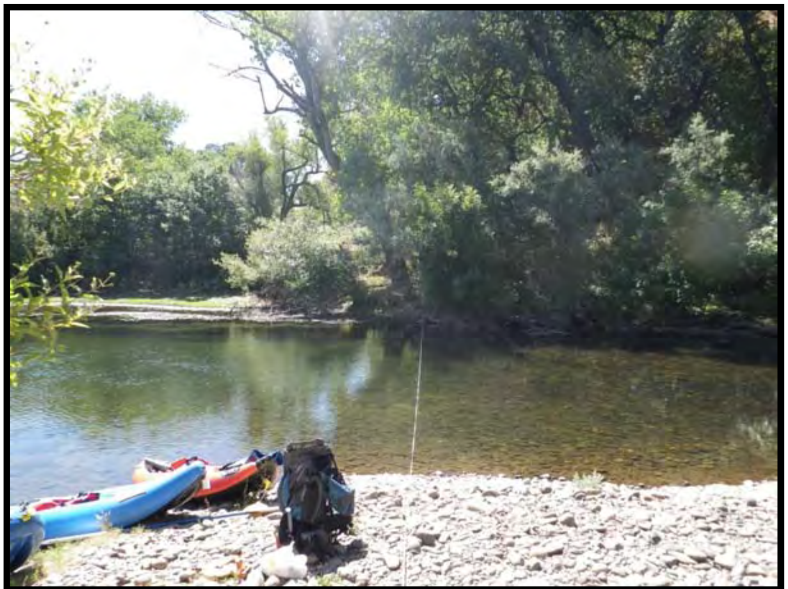
IMGP0048

Mid Flow- 250 CFS- Benchmark 83

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach



IMGP0769

Low Flow- 100 CFS- Transect 82C-
Looking Across from River Right

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

IMGP0049

Mid Flow- 250 CFS- Transect 82C
Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

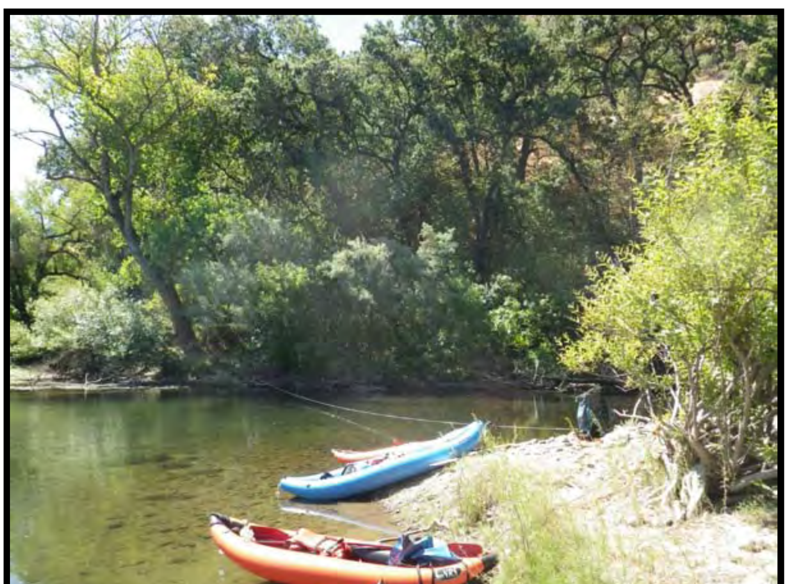
IMGP6301

High Flow- 600 CFS- Transect 82C
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach



IMGP0770

Low Flow- 100 CFS- Transect 82C-
Looking Downstream from River Left

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 82C
Looking Downstream from River Right

IMGP0050

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

High Flow- 600 CFS- Transect 82C
Looking Downstream from River Right

IMGP6302

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0771

Low Flow- 100 CFS- Transect 82C-
Looking Upstream from River Right

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0051

Mid Flow- 250 CFS- Transect 82C
Looking Upstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6303

High Flow- 600 CFS- Transect 82C
Looking Upstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0772

Low Flow- 100 CFS- Transect 82C- Looking Across
Main Channel from Far River Right Tail Pin

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0052

Mid Flow- 250 CFS- Transect 82- Looking Across Main Channel from Far River Right Tail Pin

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6304

High Flow- 600 CFS- Transect 82C- Looking Across Main Channel from Far River Right Tail Pin

July 25, 2011

Lower Tuolumne River Instream Flow Study | Bobcat Flat Reach

IMGP0773

Low Flow- 100 CFS- Transect 82C- Looking Across Side Channel from Far River Right Tail Pin

June 27, 2012

Lower Tuolumne River Instream Flow Study | Bobcat Flat Reach

IMGP0053

Mid Flow- 250 CFS- Transect 82C- Looking Across Side Channel from Far River Right Tail Pin

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6305

High Flow- 600 CFS- Transect 82C- Looking Across Side Channel from Far River Right Tail Pin

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0774

Low Flow- 100 CFS- Transect 83A- Looking Across from 1st Tail Pin River Right

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

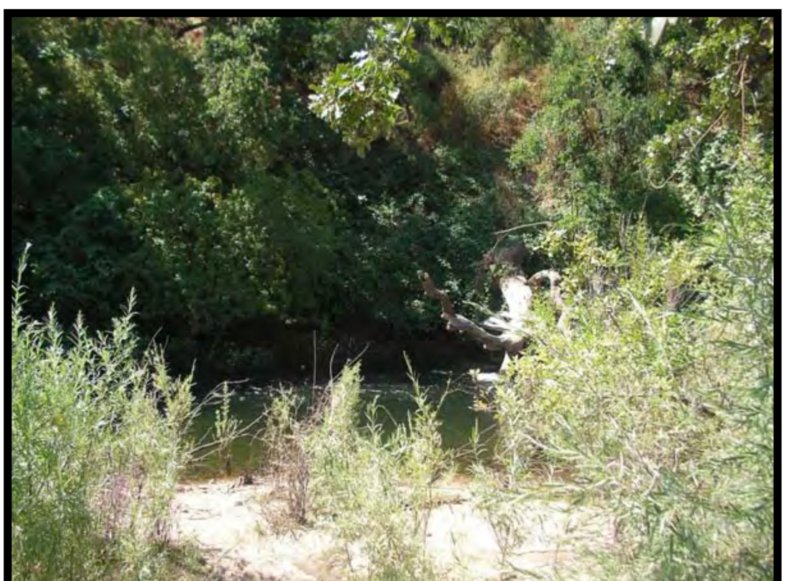
Mid Flow- 250 CFS- Transect 83A- Looking Across from 1st Tail Pin River Right

IMGP0054

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach



High Flow- 600 CFS- Transect 83A- Looking Across from 1st Tail Pin River Right

IMGP6309

July 25, 2011

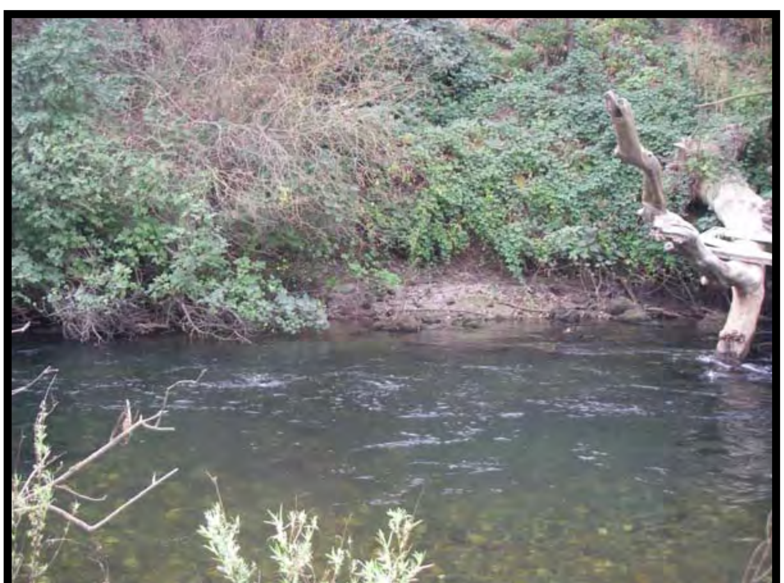
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 83A- Looking Across from Wooden Stake River Right

IMGP0775

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

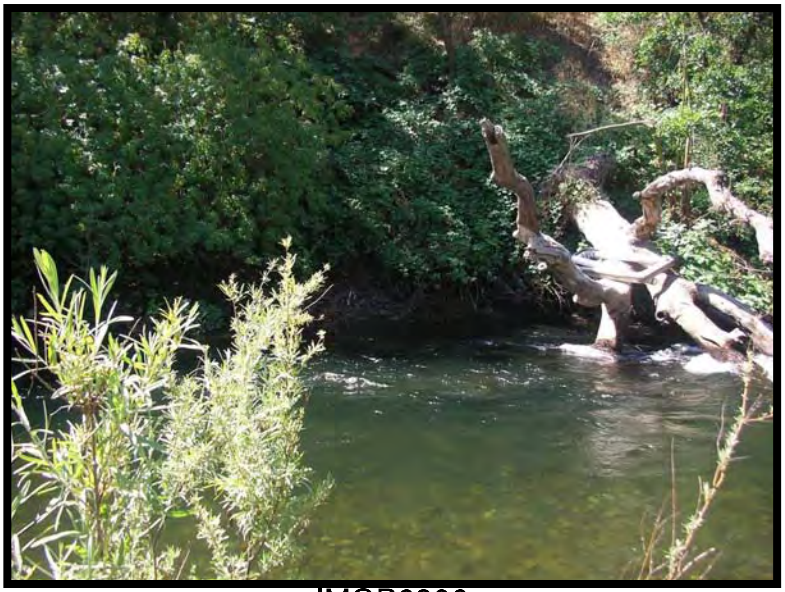


Mid Flow- 250 CFS- Transect 83A- Looking Across from Wooden Stake River Right

IMGP0055

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



High Flow- 600 CFS- Transect 83A- Looking Across from Wooden Stake River Right IMGP6306 July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 83A- Looking Downstream from River Right IMGP0776 June 27, 2012

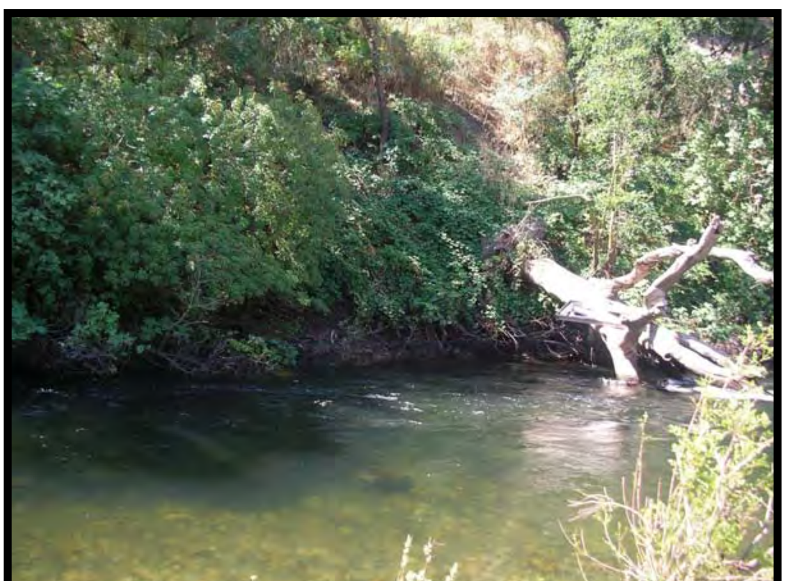
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0056

Mid Flow- 250 CFS- Transect 83A-
Looking Downstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



IMGP6307

High Flow- 600 CFS- Transect 83A-
Looking Downstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

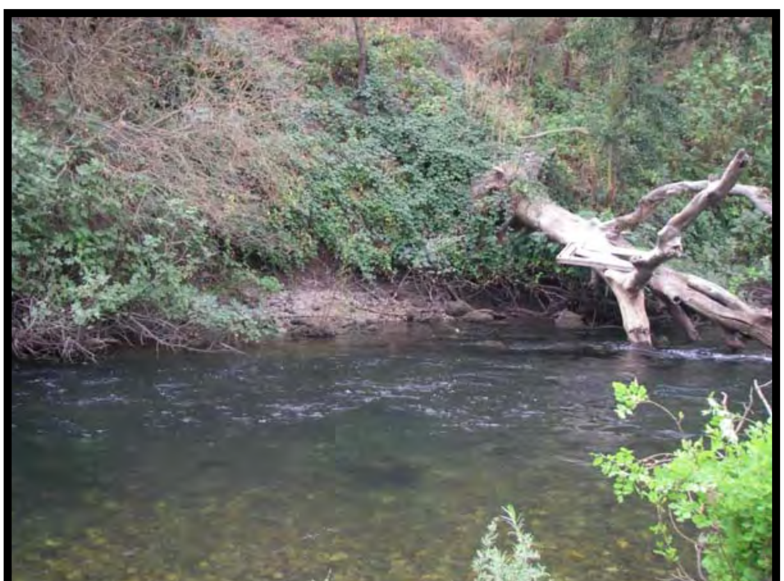
Low Flow- 100 CFS- Transect 83A-
Looking Upstream from River Right

IMGP0777

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach



Mid Flow- 250 CFS- Transect 83A-
Looking Upstream from River Right

IMGP0057

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 83A- Looking Upstream from River Right IMGP6308 July 25, 2011

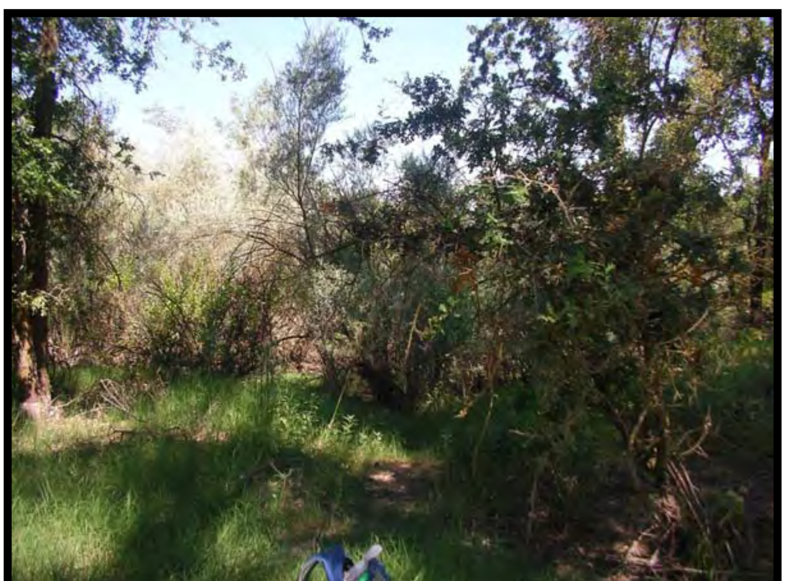
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 83A- Looking Across Side Channel from 1st Tail Pin River Right IMGP0778 June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 83A- Looking Across Side Channel from 1st Tail Pin River Right IMGP0058 September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



High Flow- 600 CFS- Transect 83A- Looking Across Side Channel from 1st Tail Pin River Right IMGP6311 July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 83A- Looking Downstream from 1st Tail Pin River Right

IMGP0779

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0059

Mid Flow- 250 CFS- Transect 83A- Looking Downstream from 1st Tail Pin River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6310

High Flow- 600 CFS- Transect 83A- Looking Downstream from 1st Tail Pin River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0062

Mid Flow- 250 CFS- Transect 83B- Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6312

High Flow- 600 CFS- Transect 83B-
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0063

Mid Flow- 250 CFS- Transect 83B0-
Looking Downstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6313

High Flow- 600 CFS- Transect 83B-
Looking Downstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0065

Mid Flow- 250 CFS- Transect 83B-
Looking Upstream from River Right

September 25, 2011

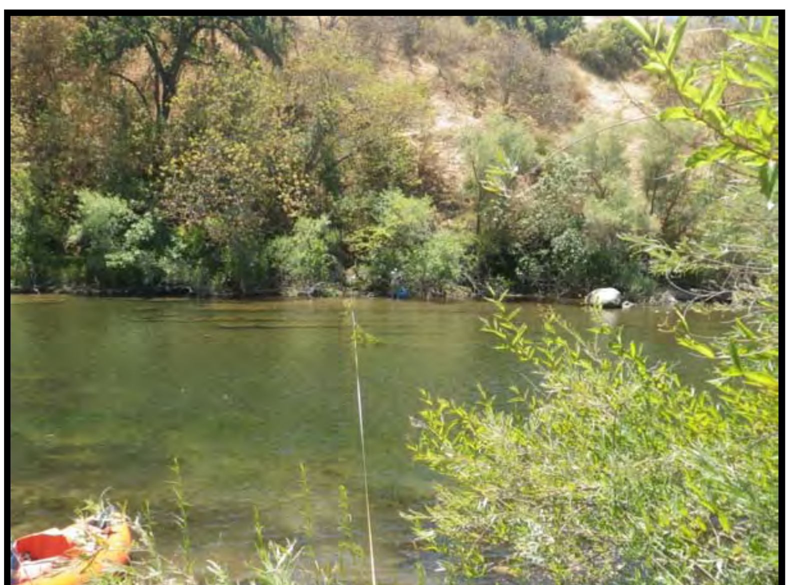
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6314

High Flow- 600 CFS- Transect 83B-
Looking Upstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



IMGP0787

Low Flow- 100 CFS- Transect 84A-
Looking Across from Tail Pin River Right

June 27, 2012

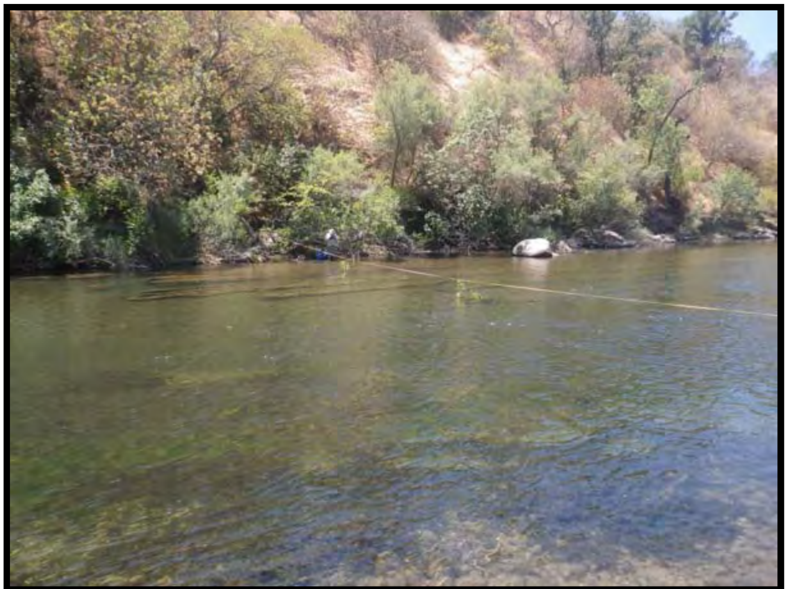
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 84A- Looking Across from Tail Pin River Right IMGP0066 September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 84A- Looking Across from Tail Pin River Right IMGP6315 July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



Low Flow- 100 CFS- Transect 84A-
Looking Downstream from River Right
IMGP0788
June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 84A-
Looking Downstream from River Right
IMGP0067
September 25, 2011

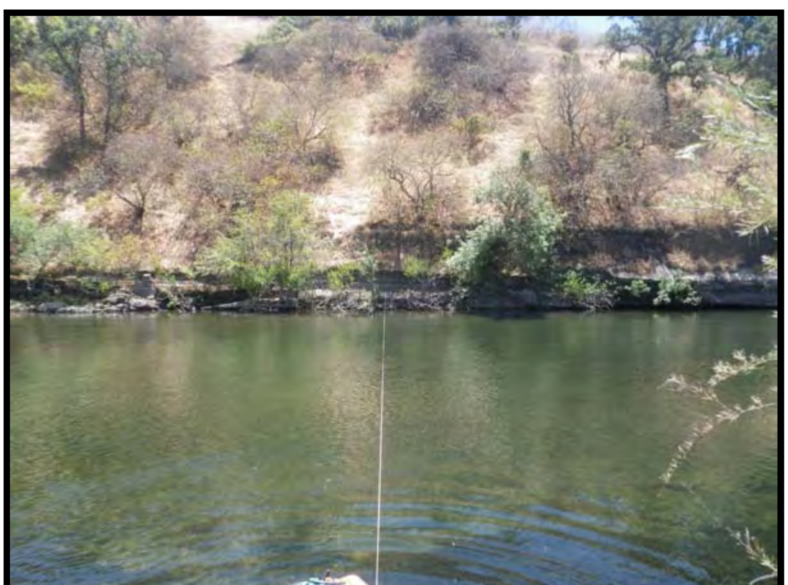
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 84A-
Looking Downstream from River Right

IMGP6316

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



Low Flow- 100 CFS- Transect 84B-
Looking Across from Tail Pin River Right

IMGP0789

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

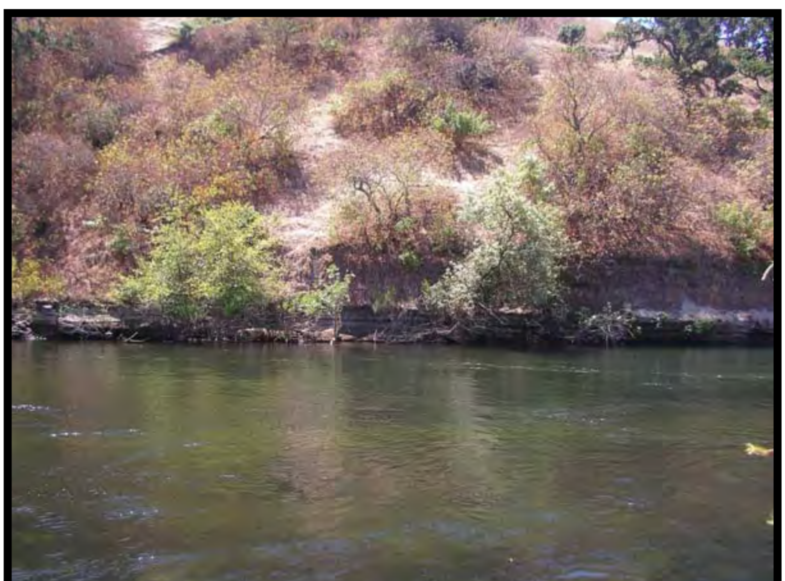
IMGP0068

Mid Flow- 250 CFS- Transect 84B-
Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

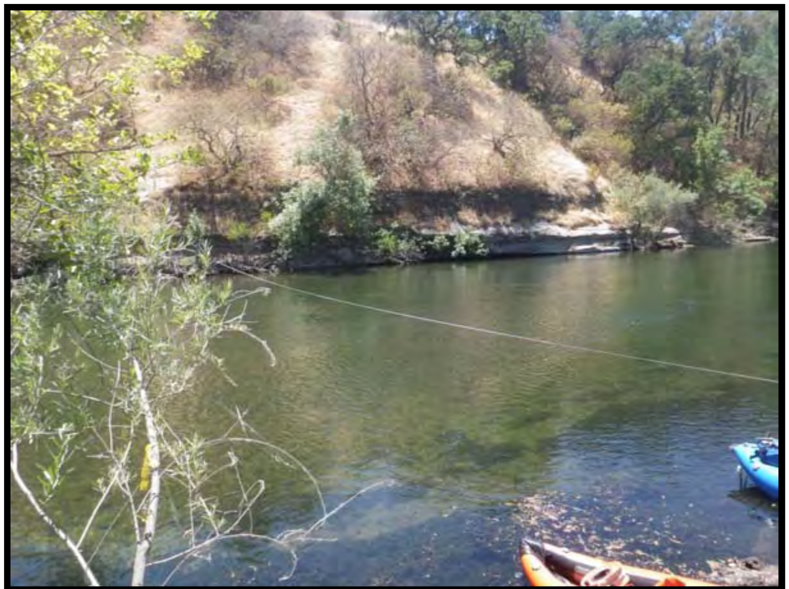


IMGP6317

High Flow- 600 CFS- Transect 84B-
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

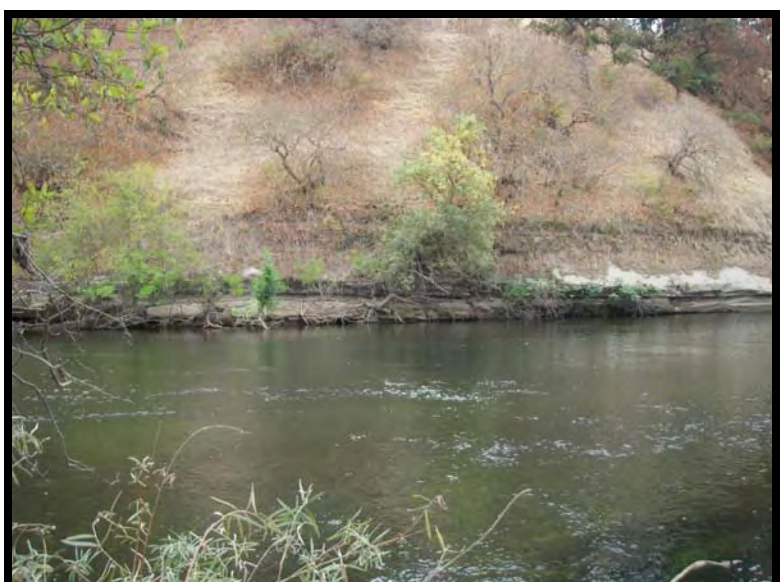


Low Flow- 100 CFS- Transect 84B-
Looking Downstream from River Right

IMGP0790

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



Mid Flow- 250 CFS- Transect 84B-
Looking Downstream from River Right

IMGP0069

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

High Flow- 600 CFS- Transect 84B-
Looking Downstream from River Right

IMGP6318

July 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Low Flow- 100 CFS- Transect 84B-
Looking Upstream from River Right

IMGP0791

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

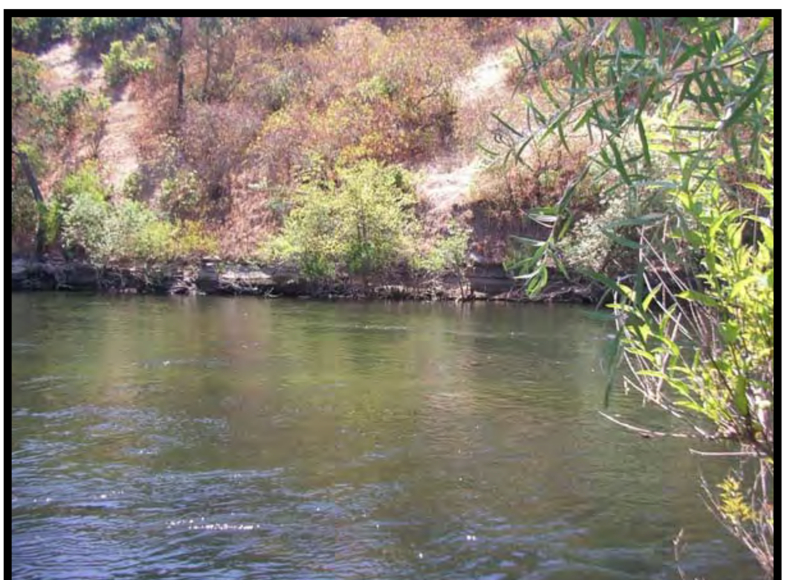
IMGP0070

Mid Flow- 250 CFS- Transect 84B-
Looking Upstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

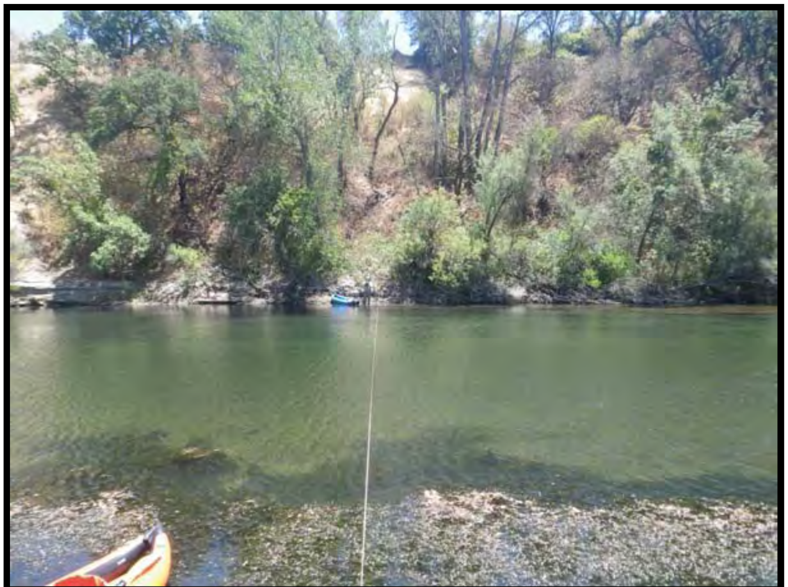


IMGP6319

High Flow- 600 CFS- Transect 84B-
Looking Upstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



Low Flow- 100 CFS- Transect 84C-
Looking Across from River Right
IMGP0792
June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 84C-
Looking Across from River Right
IMGP0071
September 25, 2011

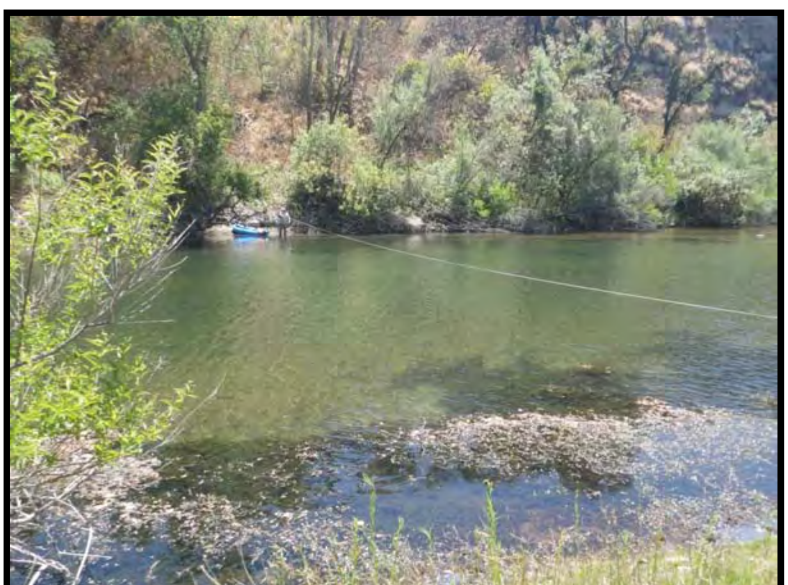
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP6320

High Flow- 600 CFS- Transect 84C-
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



IMGP0793

Low Flow- 100 CFS- Transect 84C-
Looking Downstream from River Right

June 27, 2012

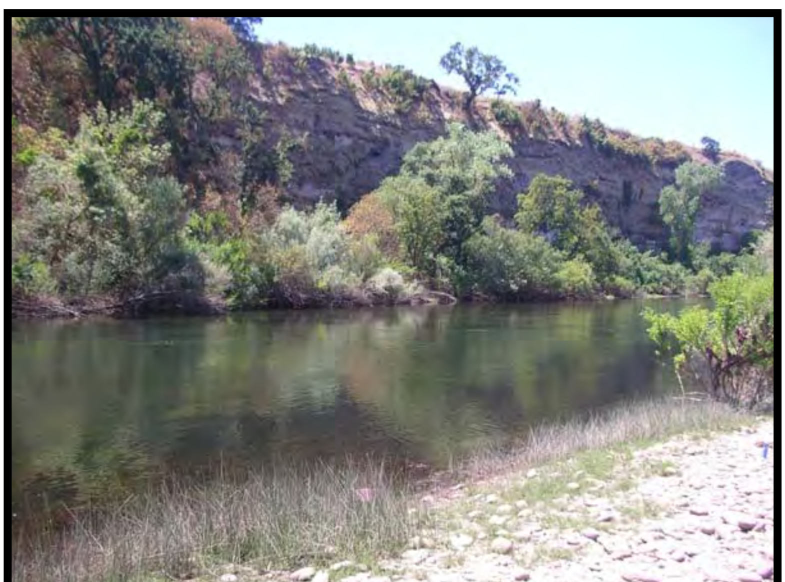
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0072

Mid Flow- 250 CFS- Transect 84C-
Looking Downstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



IMGP6321

High Flow- 600 CFS- Transect 84C-
Looking Downstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Low Flow- 100 CFS- Transect 84C-
Looking Upstream from River Right

IMGP0794

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 84C-
Looking Upstream from River Right

IMGP0074

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 84C-
Looking Upstream from River Right
IMGP6322
July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 85A-
Looking Across from Tail Pin River Right
IMGP0796
June 27, 2012

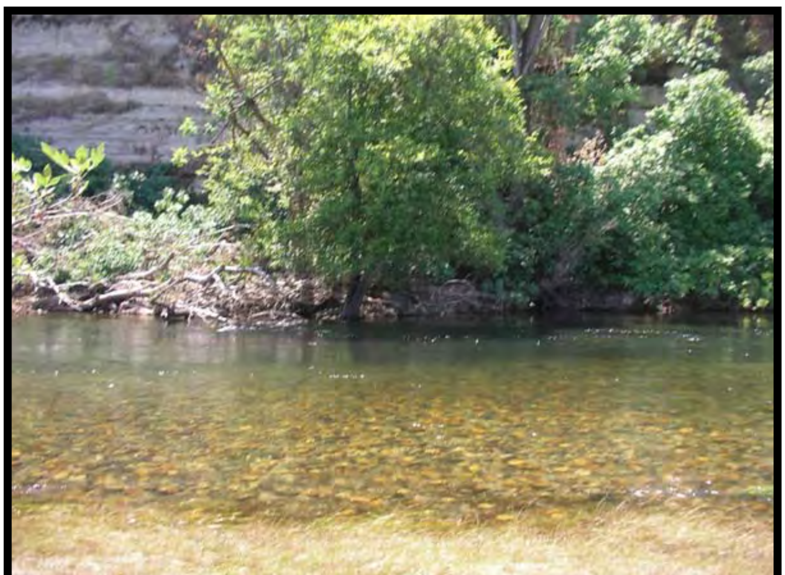
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0079

Mid Flow- 250 CFS- Transect 85A-
Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



IMGP6323

High Flow- 600 CFS- Transect 85A-
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Low Flow- 100 CFS- Transect 85A- Looking Downstream from River Right

IMGP0797

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 85A- Looking Downstream from River Right

IMGP0080

September 25, 2011

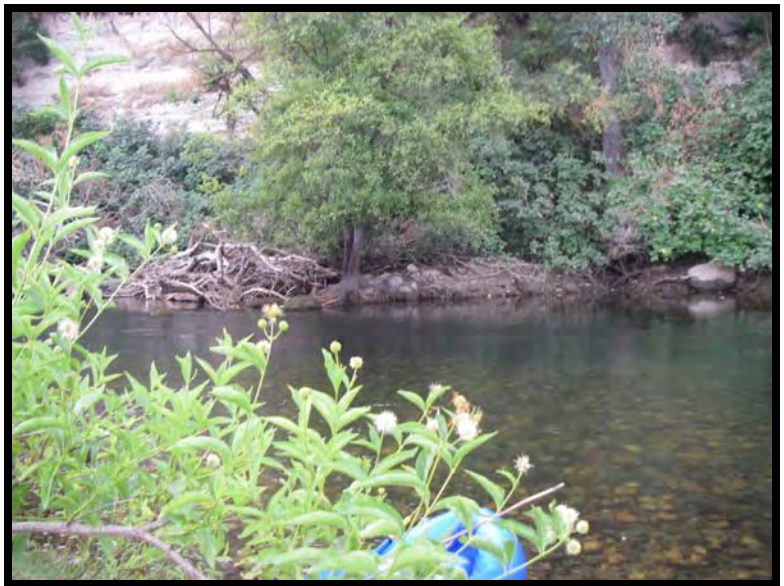
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 85A-
Looking Downstream from River Right
IMGP6324
July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 85A-
Looking Upstream from River Right
IMGP0798
June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

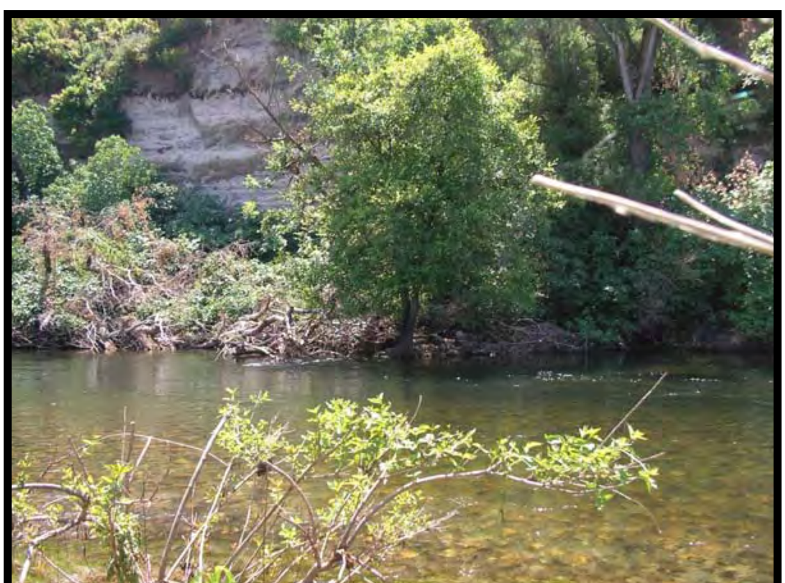


Mid Flow- 250 CFS- Transect 85A-
Looking Upstream from River Right

IMGP0081

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



High Flow- 600 CFS- Transect 85A-
Looking Upstream from River Right

IMGP6326

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86A-
Looking Across from Tail Pin River Right IMGP0800 June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 86A-
Looking Across from River Right IMGP0082 September 25, 2011

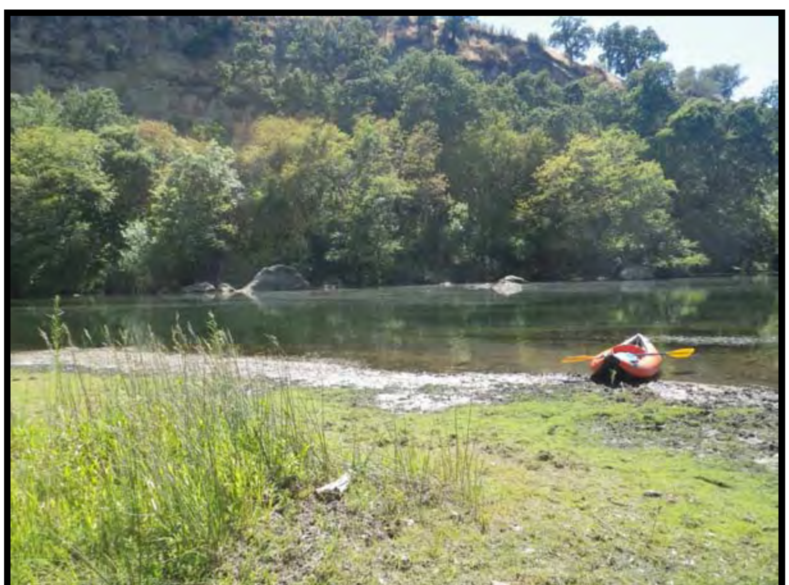
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 86A-
Looking Across from River Right

IMGP6327

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



Low Flow- 100 CFS- Transect 86A-
Looking Downstream from River Right

IMGP0799

June 27, 2012

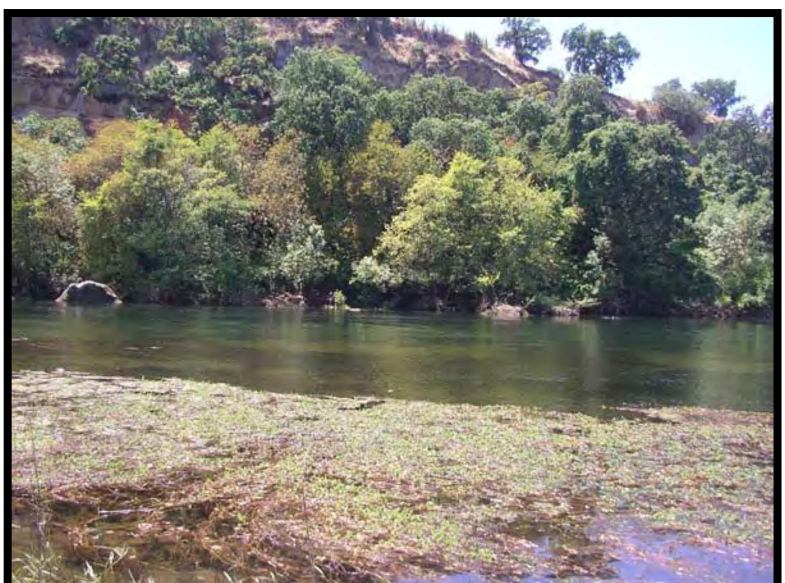
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

IMGP0083

Mid Flow- 250 CFS- Transect 86A-
Looking Downstream from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



IMGP6328

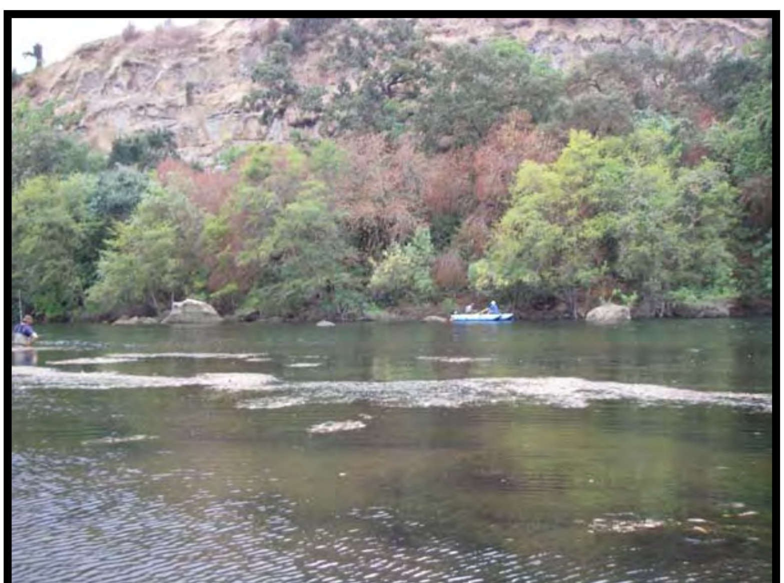
High Flow- 600 CFS- Transect 86A-
Looking Downstream from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86A- Looking Upstream from River Right IMGP0801 June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

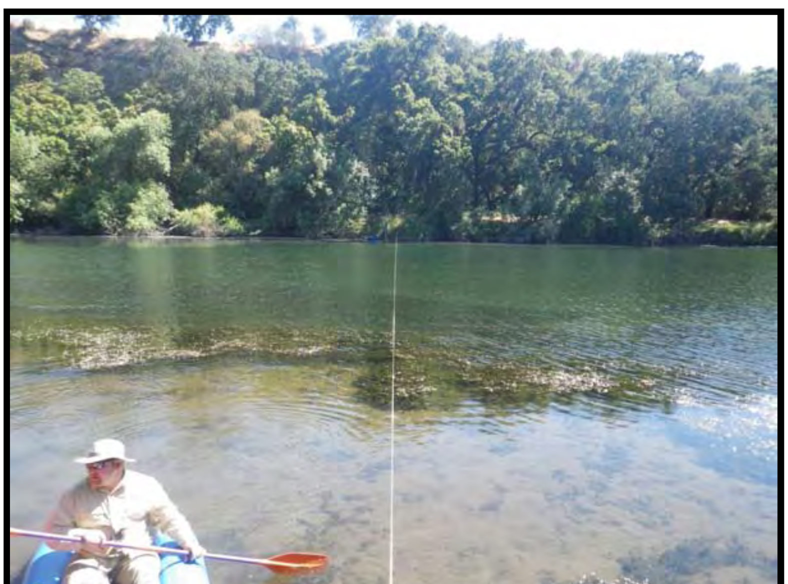


Mid Flow- 250 CFS- Transect 86A- Looking Upstream from River Right IMGP0084 September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 86A-
Looking Upstream from River Right
IMGP6329
July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



Low Flow- 100 CFS- Transect 86B-
Looking Across from Tail Pin River Right
IMGP0806
June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

IMGP0085

Mid Flow- 250 CFS- Transect 86B-
Looking Across from River Right

September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

IMGP6330

High Flow- 600 CFS- Transect 86B-
Looking Across from River Right

July 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86B-
Looking Downstream from River Right

IMGP0807

June 27, 2012

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 86B-
Looking Downstream from River Right

IMGP0087

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 86B-
Looking Downstream from River Right

IMGP6331

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86B-
Looking Upstream from River Right

IMGP0808

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 86B- Looking Upstream from River Right

IMGP0088

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 86B- Looking Upstream from River Right

IMGP6332

July 25, 2011

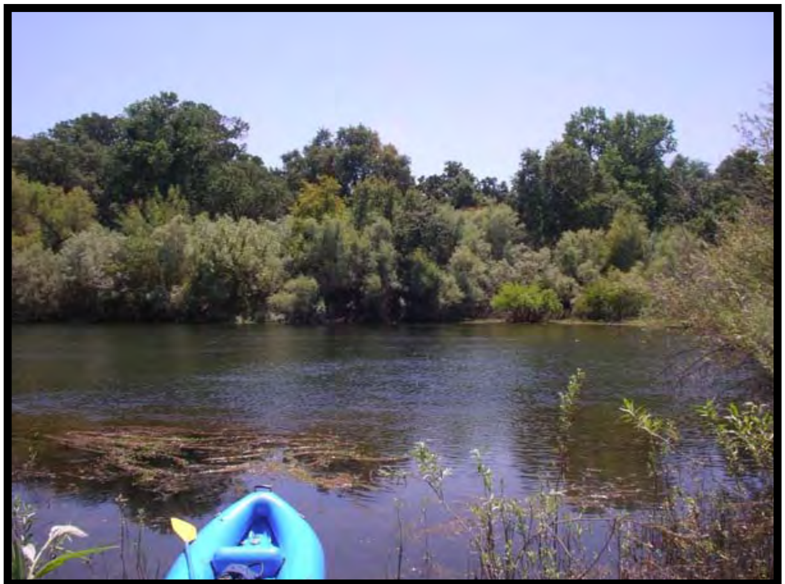
Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86C- Looking Across from Tail Pin River Right IMGP0809 June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 86C- Looking Across from River Right IMGP0089 September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach



High Flow- 600 CFS- Transect 86C-
Looking Across from River Right

IMGP6333

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86C-
Looking Downstream from River Right

IMGP0810

June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 86C- Looking Downstream from River Right

IMGP0090

September 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

High Flow- 600 CFS- Transect 86C- Looking Downstream from River Right

IMGP6334

July 25, 2011

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Low Flow- 100 CFS- Transect 86C- Looking Upstream from River Right IMGP0811 June 27, 2012

Lower Tuolumne River Instream Flow Study Bobcat Flat Reach

Mid Flow- 250 CFS- Transect 86C- Looking Upstream from River Right IMGP0091 September 25, 2011

Lower Tuolumne River Instream Flow Study

Bobcat Flat Reach

IMGP6335

High Flow- 600 CFS- Transect 86C-
Looking Upstream from River Right

July 25, 2011

Instream Flow Study

Lower Tuolumne River
Santa Fe Reach

July 28, 2011, September 26, 2011, & June 28, 2012

R. Liebig, K. Jarrett, I. Pryor, W. Swaney, S. Araya, K. Orr, N. Jurjavcic, R. McLintock, H. Bowen, M. Reymann, and K. Rodriguez

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 155A- Looking Across from Tail Pin River Right IMGP0822 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 155A- Looking Across from Tail Pin River Right IMGP0092 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 155A- Looking Across From Tail Pin River Right IMGP6339 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 155A-
Looking Downstream from River Right
IMGP0824
June 28, 2012

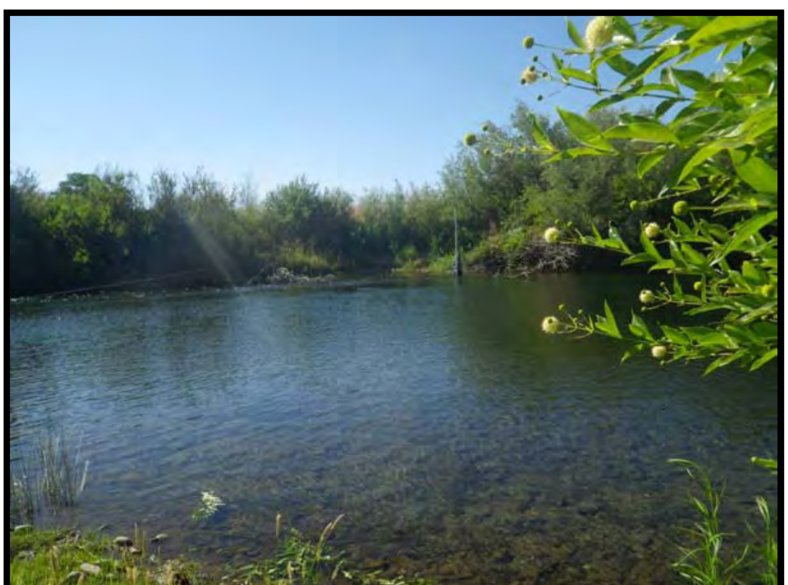
Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 155A-
Looking Downstream from River Right
IMGP0093
September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 155A-
Looking Downstream from River Right
IMGP6340
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Low Flow- 100 CFS- Transect 155A-
Looking Upstream from River Right
IMGP0823
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 155A-
Looking Upstream from River Right

IMGP0094

September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 155A-
Looking Upstream from River Right

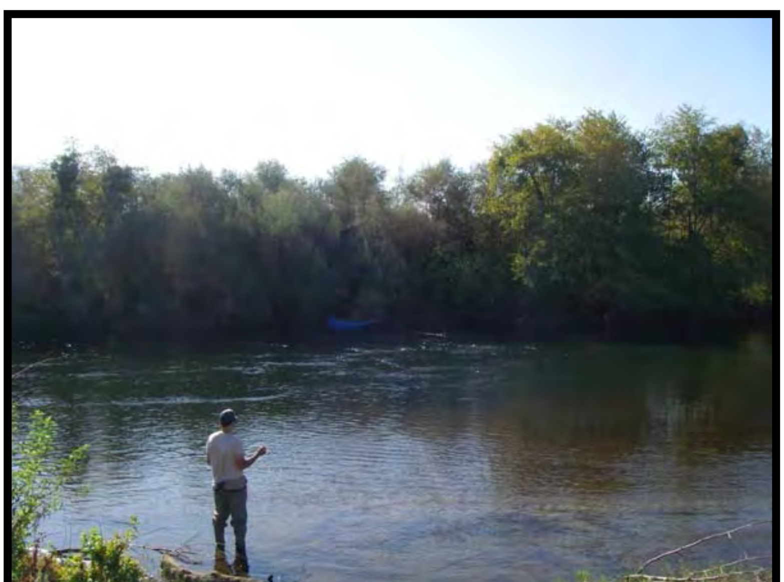
IMGP6341

July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 155B- Looking Across from Tail Pin River Right IMGP0826 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Medium Flow- 250 CFS- Transect 155B- Looking Across from Tail Pin River Right IMGP0095 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 155B-
Looking Across from Tail Pin River Right
IMGP6342
July 28, 2011

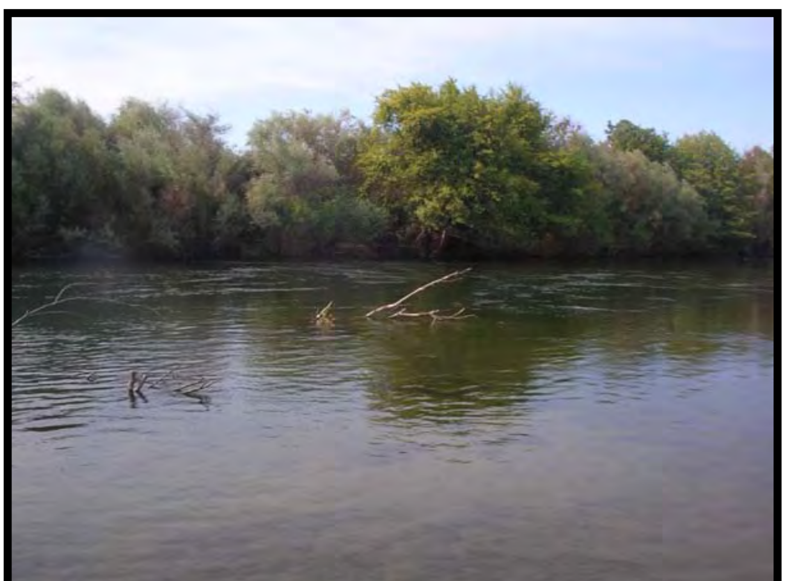
Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 155B-
Looking Downstream from River Right
IMGP0825
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 155B- Looking Downstream from River Right IMGP0096 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

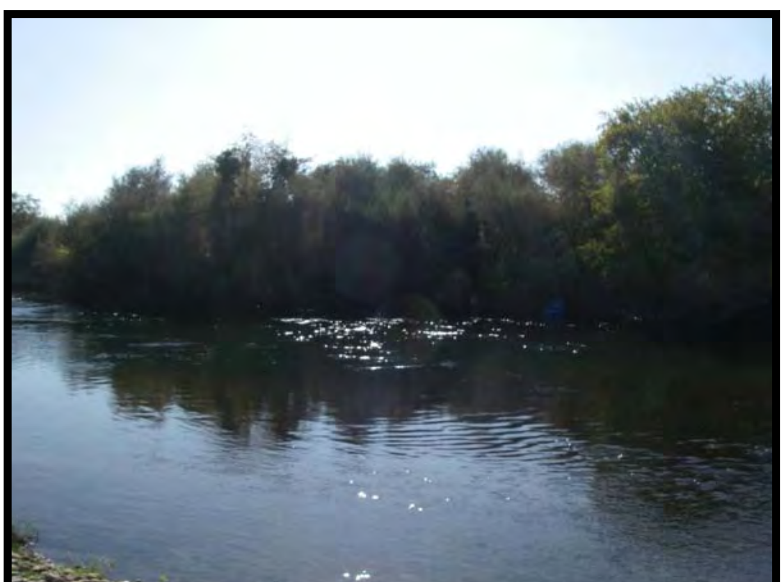


High Flow- 600 CFS- Transect 155B- Looking Downstream from River Right IMGP6343 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 155B- Looking Upstream from River Right IMGP0827 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

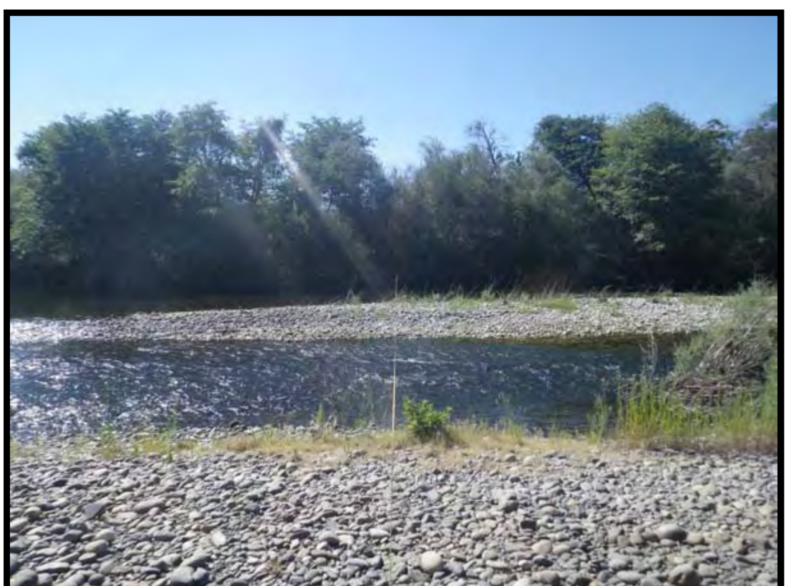


Medium Flow- 250 CFS- Transect 155B- Looking Upstream from River Right IMGP0097 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 155B- Looking Upstream from River Right IMGP6344 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

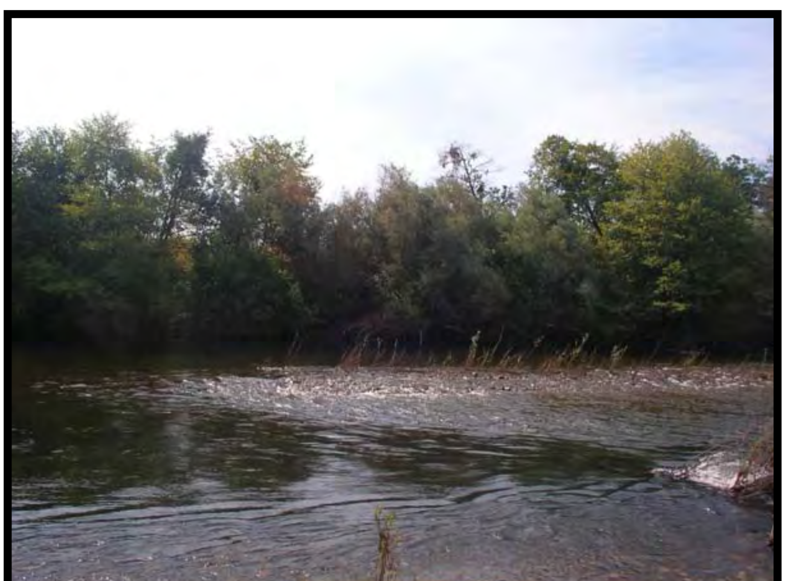


Low Flow- 100 CFS- Transect 156A- Looking Across from Tail Pin River Right IMGP0830 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 156A- Looking Across from Tail Pin River Right IMGP0099 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach



High Flow- 600 CFS- Transect 156A- Looking Across from Tail Pin River Right IMGP6346 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 156A- Looking Downstream from River Right IMGP0829 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 156A- Looking Downstream from River Right IMGP0098 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 156A- Looking Downstream from River Right IMGP6345 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 156A- Looking Upstream from River Right IMGP0831 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 156A- Looking Upstream from River Right IMGP0102 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 156A- Looking Upstream from River Right IMGP6347 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 156B- Looking Across from Tail Pin River Right

IMGP0832

June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 156B- Looking Across from Tail Pin River Right

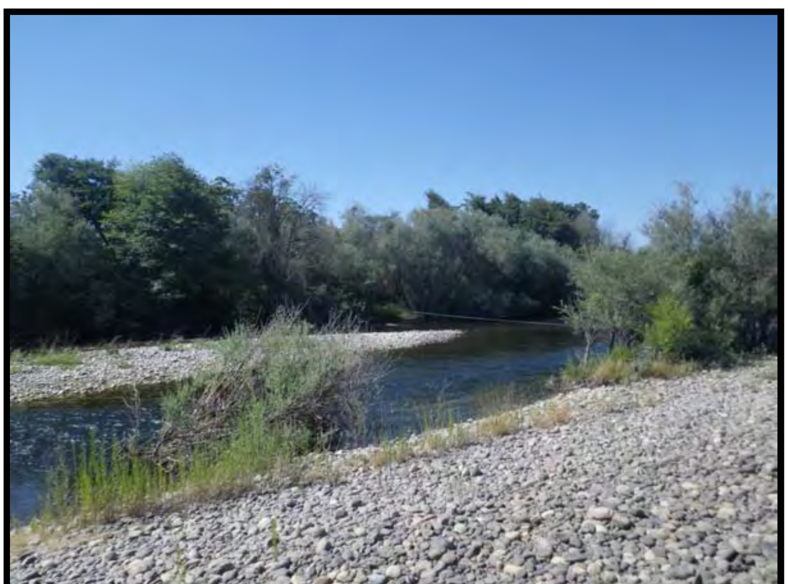
IMGP0105

September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 156B-
Looking Across from Tail Pin River Right IMGP6349 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Low Flow- 100 CFS- Transect 156B-
Looking Downstream from River Right IMGP0834 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 156B- Looking Downstream from River Right IMGP0103 September 26, 2011

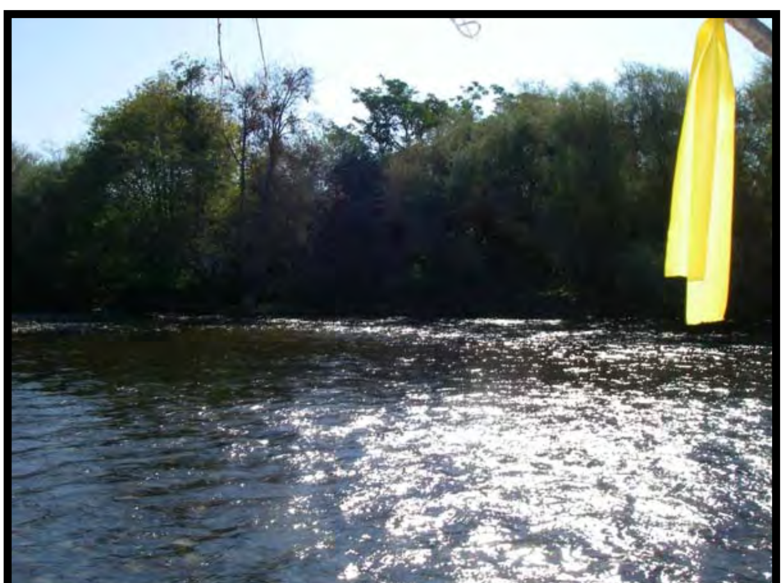
Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 156B- Looking Downstream from River Right IMGP6348 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 156B- Looking Upstream from River Right IMGP0833 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Medium Flow- 250 CFS- Transect 156B- Looking Upstream from River Right IMGP0106 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 156B-
Looking Upstream from River Right
IMGP6350
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159A-
Looking Across from Tail Pin River Right
IMGP0837
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159A- Looking Across from Tail Pin River Right IMGP0107 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159A- Looking Across from Tail Pin River Right IMGP6351 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159A- Looking Downstream from River Right IMGP0838 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159A- Looking Downstream from River Right IMGP0108 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159A- Looking Downstream from River Right IMGP6352 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159A- Looking Upstream from River Right IMGP0839 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159A-
Looking Upstream from River Right
IMGP0109
September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159A-
Looking Upstream from River Right
IMGP6356
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159B- Looking Across from Tail Pin River Right IMGP0840 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159B- Looking Across from Tail Pin River Right IMGP0111 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159B-
Looking Across from Tail Pin River Right
IMGP6357
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159B-
Looking Downstream from River Right
IMGP0841
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159B- Looking Downstream from River Right IMGP0112 September 26, 2011

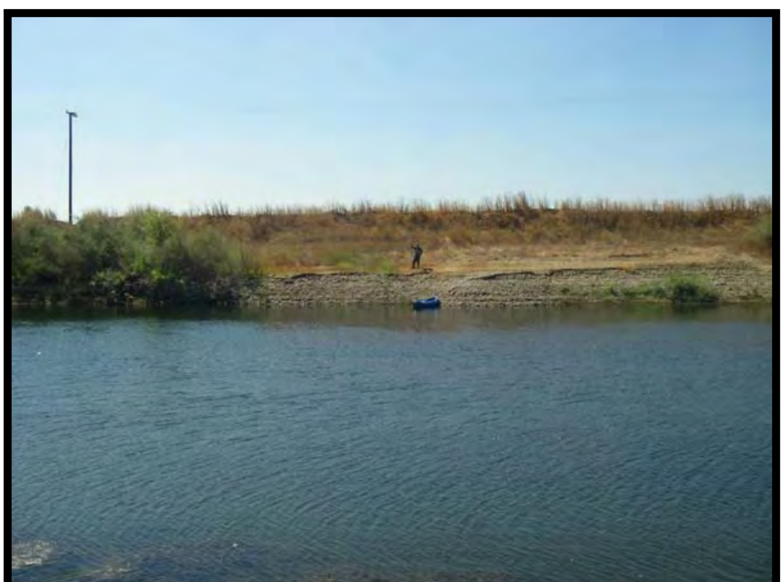
Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159B- Looking Downstream from River Right IMGP6358 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159B- Looking Upstream from River Right IMGP0842 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

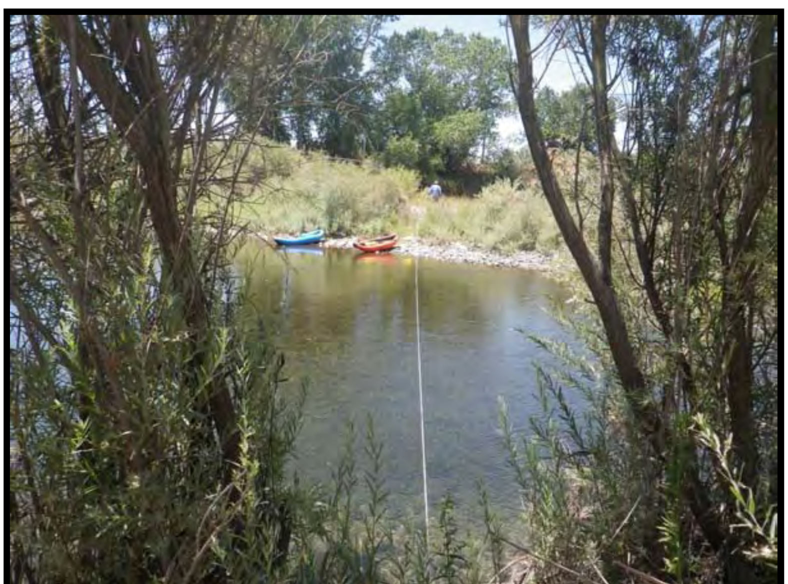


Medium Flow- 250 CFS- Transect 159B- Looking Upstream from River Right IMGP0113 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159B-
Looking Upstream from River Right IMGP6359 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Low Flow- 100 CFS- Transect 159C-
Looking Across from Tail Pin River Right IMGP0844 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159C- Looking Across from Tail Pin River Right IMGP0114 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159C- Looking Across from Tail Pin River Right IMGP6360 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159C- Looking Downstream from River Right IMGP0843 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159C- Looking Downstream from River Right IMGP0115 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159C-
Looking Downstream from River Right
IMGP6361
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 159C-
Looking Upstream from River Right
IMGP0845
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 159C- Looking Upstream from River Right IMGP0116 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 159C- Looking Upstream from River Right IMGP6362 July 28, 2011

Lower Tuolumne River Instream Flow Study — Santa Fe Reach

Low Flow- 100 CFS- Transect 160A- Looking Across from Tail Pin River Right — IMGP0847 — June 28, 2012

Lower Tuolumne River Instream Flow Study — Santa Fe Reach

Medium Flow- 250 CFS- Transect 160A- Looking Across from Tail Pin River Right — IMGP0117 — September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 160A-
Looking Across from Tail Pin River Right

IMGP6363

July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 160A-
Looking Downstream from River Right

IMGP0846

June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 160A- Looking Downstream from River Right IMGP0118 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 160A- Looking Downstream from River Right IMGP6364 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 160A-
Looking Upstream from River Right
IMGP0848
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 160A-
Looking Upstream from River Right
IMGP0119
September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 160A-
Looking Upstream from River Right
IMGP6365
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 160B-
Looking Across from Tail Pin River Right
IMGP0850
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 160B-
Looking Across from Tail Pin River Right IMGP0121 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 160B-
Looking Across from Tail Pin River Right IMGP6367 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 160B- Looking Downstream from River Right IMGP0849 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 160B- Looking Downstream from River Right IMGP0120 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 160B-
Looking Downstream from River Right
IMGP6366
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 160B-
Looking Upstream from River Right
IMGP0851
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 160B- Looking Upstream from River Right IMGP0122 September 26, 2011

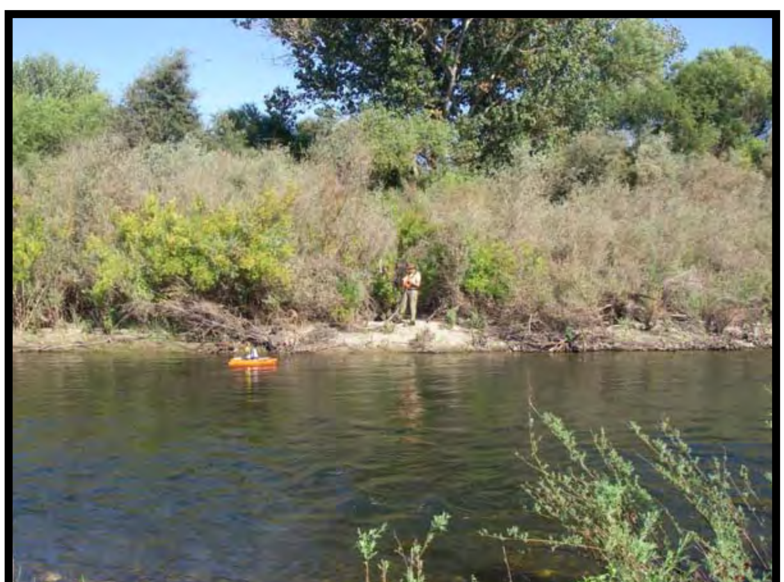
Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 160B- Looking Upstream from River Right IMGP6368 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 161A- Looking Across from Tail Pin River Right IMGP0852 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Medium Flow- 250 CFS- Transect 161A- Looking Across from Tail Pin River Right IMGP0123 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 161A-
Looking Across from Head Pin River Right
IMGP6369
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 161A-
Looking Downstream from River Left
IMGP0853
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 161A- Looking Downstream from River Left

IMGP0124

September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 161A- Looking Downstream from River Left

IMGP6370

July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 161A- Looking Upstream from River Left IMGP0854 June 28, 2012

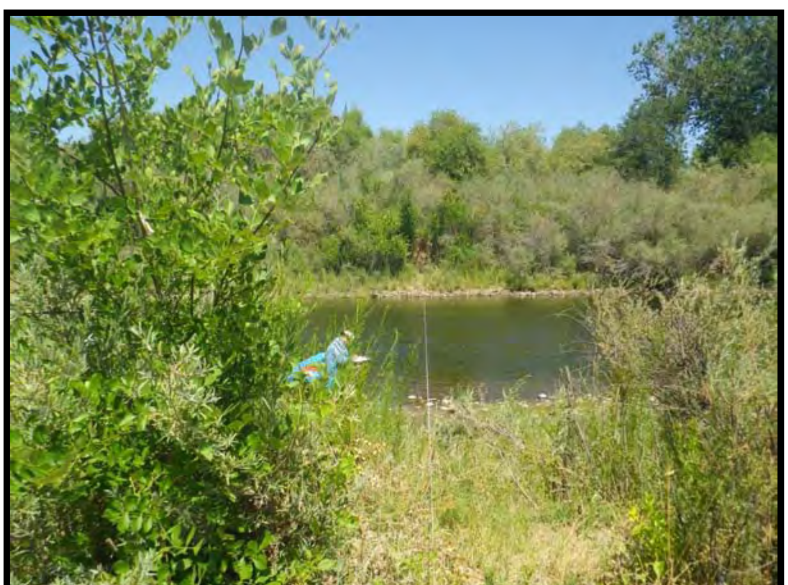
Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 161A- Looking Upstream from River Left IMGP0125 September 26, 2011

Lower Tuolumne River Instream Flow Study — Santa Fe Reach

High Flow- 600 CFS- Transect 161A-
Looking Upstream from River Left
IMGP6371
July 28, 2011

Lower Tuolumne River Instream Flow Study — Santa Fe Reach

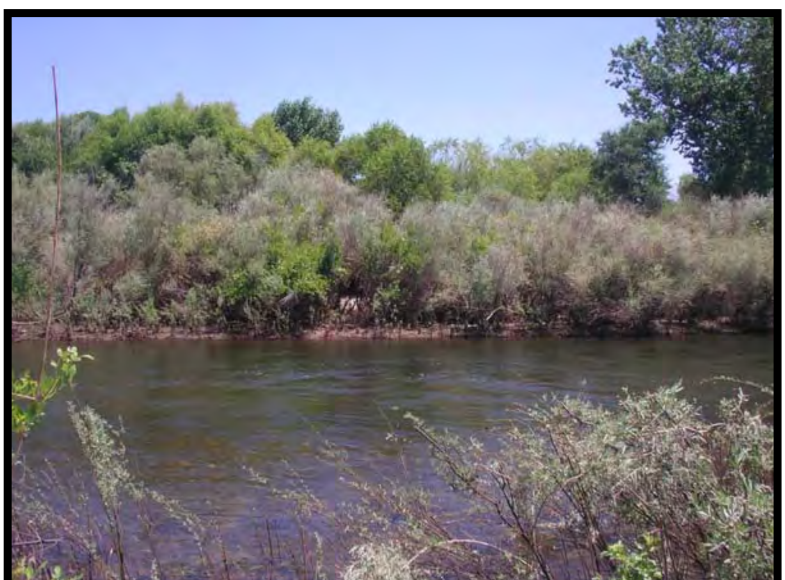


Low Flow- 100 CFS- Transect 161B-
Looking Across from Head Pin River Left
IMGP0856
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

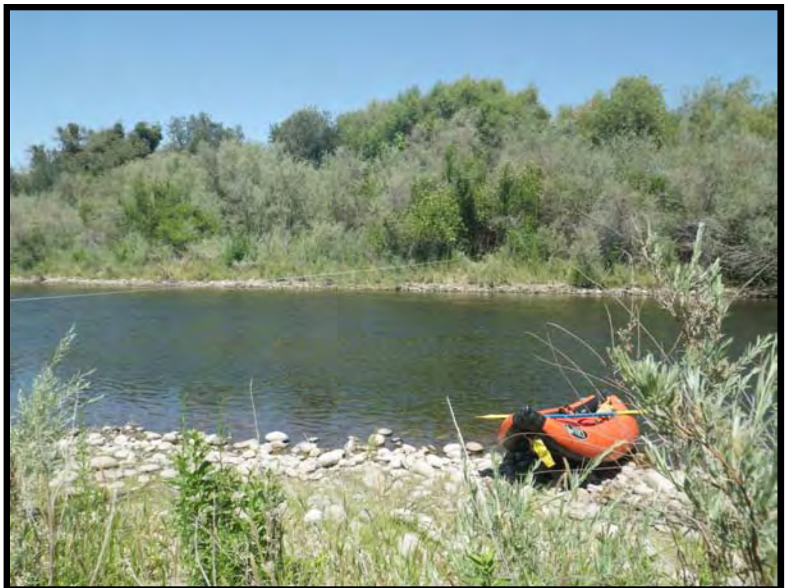
Medium Flow- 250 CFS- Transect 161B- Looking Across from Head Pin River Left IMGP0126 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach



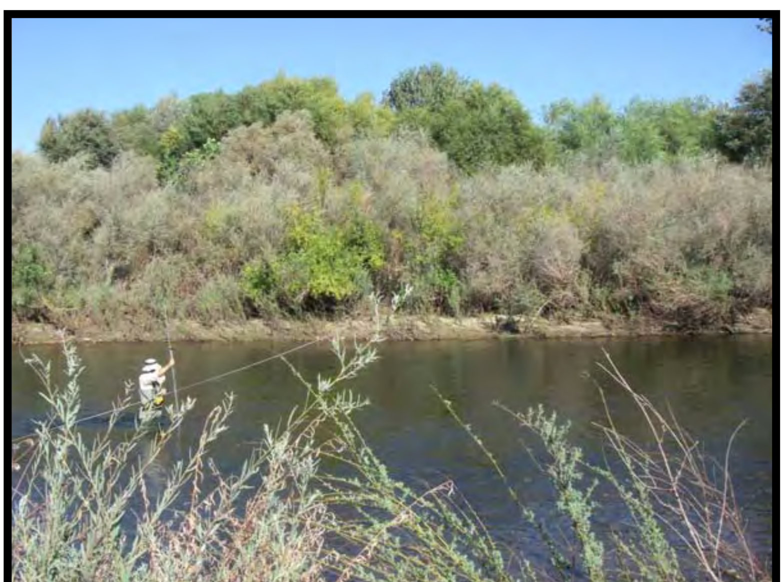
High Flow- 600 CFS- Transect 161B- Looking Across from Head Pin River Left IMGP6372 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Low Flow- 100 CFS- Transect 161B-
Looking Downstream from River Left
IMGP0855
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach



Medium Flow- 250 CFS- Transect 161B-
Looking Downstream from River Left
IMGP0127
September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 161B- Looking Downstream from River Left IMGP6373 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 161B- Looking Upstream from River Left IMGP0857 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 161B- Looking Upstream from River Left

IMGP0128

September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 161B- Looking Upstream from River Left

IMGP6374

July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163A- Looking Across from Head Pin River Left IMGP0859 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 162A- Looking Across from Head Pin River Left IMGP0129 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 162A- Looking Across from Head Pin River Left IMGP6375 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 162A- Looking Downstream from River Left IMGP0861 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 162A- Looking Downstream from River Left IMGP0130 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 162A- Looking Downstream from River Left IMGP6376 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 162A- Looking Upstream from 163A Head Pin River Left IMGP0858 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 162A- Looking Upstream from River Left IMGP0131 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 162A-
Looking Upstream from River Left IMGP6377 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163A-
Looking Across from Head Pin River Left IMGP0859 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163A-
Looking Across from Head Pin River Left

IMGP0132

September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163A-
Looking Across from Head Pin River Left

IMGP6378

July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163A- Looking Downstream from River Left IMGP0862 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163A- Looking Downstream from River Left IMGP0133 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163A-
Looking Downstream from River Left
IMGP6379
July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163A-
Looking Upstream from River Left
IMGP0864
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163A- Looking Upstream from River Left IMGP0134 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163A- Looking Upstream from River Left IMGP6380 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163B- Looking Across from Head Pin River Left
IMGP0863
June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163B- Looking Across from Head Pin River Left
IMGP0135
September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163B-
Looking Across from Head Pin River Left IMGP6381 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163B-
Looking Downstream from River Left IMGP0136 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163B- Looking Downstream from River Left IMGP6382 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163B- Looking Upstream from River Left IMGP0137 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163B- Looking Upstream from River Left IMGP6383 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163C- Looking Across from Head Pin River Left IMGP0868 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163C- Looking Across from Head Pin River Left IMGP0140 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163C- Looking Across from Head Pin River Left IMGP6384 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

IMGP0866

Low Flow- 100 CFS- Transect 163C-
Looking Downstream from River Left

June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

IMGP0138

Medium Flow- 250 CFS- Transect 163C-
Looking Downstream from River Left

September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163C- Looking Downstream from River Left IMGP6385 July 28, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Low Flow- 100 CFS- Transect 163C- Looking Upstream from River Left IMGP0869 June 28, 2012

Lower Tuolumne River Instream Flow Study Santa Fe Reach

Medium Flow- 250 CFS- Transect 163C- Looking Upstream from River Left IMGP0139 September 26, 2011

Lower Tuolumne River Instream Flow Study Santa Fe Reach

High Flow- 600 CFS- Transect 163C- Looking Upstream from River Left IMGP6386 July 28, 2011

Instream Flow Study

Lower Tuolumne River
Waterford Reach

July 29, 2011, September 27, 2011, & June 29, 2012

R. Liebig, K. Jarrett, I. Pryor, W. Swaney, S. Araya, K. Orr, N. Jurjavcic, R. McLintock, H. Bowen, M. Reymann, and K. Rodriguez

Lower Tuolumne River Instream Flow Study Waterford Reach

Low Flow- 100 CFS- Transect 205A- Looking Across from Head Pin

IMGP0876

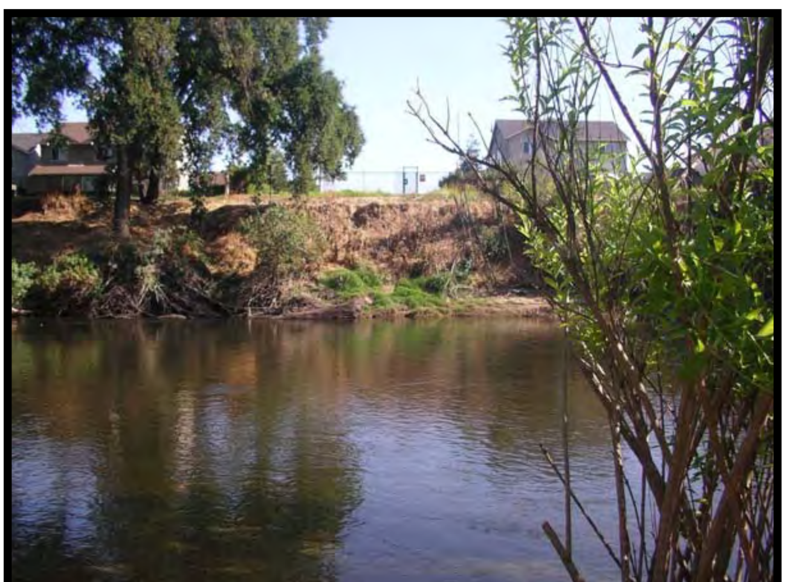
June 29, 2012

Lower Tuolumne River Instream Flow Study Waterford Reach

IMGP0162

Medium Flow- 250 CFS- Transect 205A- Looking Across from Head Pin September 27, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach



IMGP6390

High Flow- 600 CFS- Transect 205A- Looking Across from Head Pin July 29, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

Low Flow- 100 CFS- Transect 205A- Looking Downstream from River Left IMGP0875 June 29, 2012

Lower Tuolumne River Instream Flow Study Waterford Reach

Medium Flow- 250 CFS- Transect 205A- Looking Downstream from River Left IMGP0165 September 27, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

High Flow- 600 CFS- Transect 205A-
Looking Downstream from River Left
IMGP6392
July 29, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

Low Flow- 100 CFS- Transect 205A-
Looking Upstream from River Left
IMGP0877
June 29, 2012

Lower Tuolumne River Instream Flow Study Waterford Reach

Medium Flow- 250 CFS- Transect 205A- Looking Upstream from River Left IMGP0166 September 27, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

High Flow- 600 CFS- Transect 205A- Looking Upstream from River Left IMGP6391 July 29, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

Low Flow- 100 CFS- Transect 205B- Looking Across from Head Pin IMGP0879 June 29, 2012

Lower Tuolumne River Instream Flow Study Waterford Reach

Medium Flow- 250 CFS- Transect 205B- Looking Across from Head Pin IMGP0167 September 27, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

High Flow- 600 CFS- Transect 205B- Looking Across from Head Pin IMGP6387 July 29, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

Low Flow- 100 CFS- Transect 205B- Looking Downstream from River Left IMGP0878 June 29, 2012

Lower Tuolumne River Instream Flow Study Waterford Reach

Medium Flow- 250 CFS- Transect 205B- Looking Downstream from River Left IMGP0168 September 27, 2011

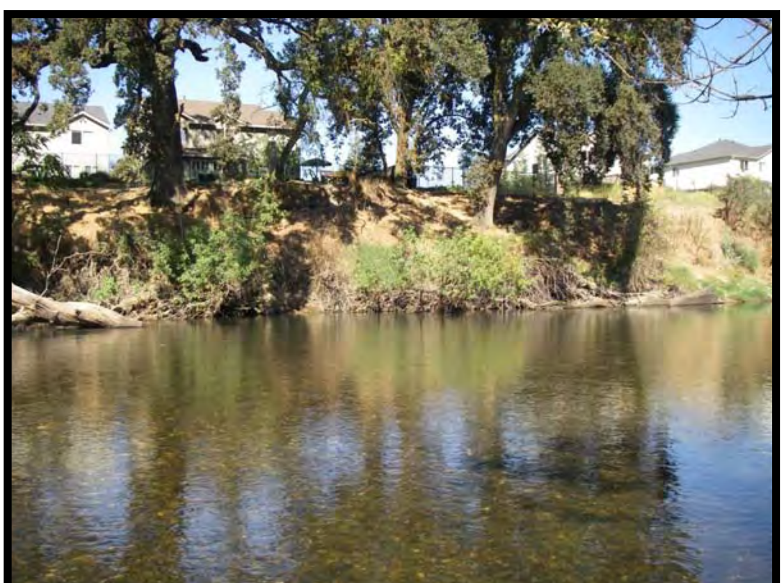
Lower Tuolumne River Instream Flow Study Waterford Reach

High Flow- 600 CFS- Transect 205B- Looking Downstream from River Left IMGP6389 July 29, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

Low Flow- 100 CFS- Transect 205B- Looking Upstream from River Left IMGP0880 June 29, 2012

Lower Tuolumne River Instream Flow Study Waterford Reach



Medium Flow- 250 CFS- Transect 205B- Looking Upstream from River Left IMGP0169 September 27, 2011

Lower Tuolumne River Instream Flow Study Waterford Reach

High Flow- 600 CFS- Transect 205B- Looking Upstream from River Left IMGP6388 July 29, 2011

Instream Flow Study

Lower Tuolumne River
Delaware Reach

July 29, 2011, September 27, 2011,
& June 29, 2012

R. Liebig, K. Jarrett, I. Pryor, W. Swaney, S. Araya, K. Orr, N. Jurjavcic, R. McLintock, H. Bowen, M. Reymann, and K. Rodriguez

Lower Tuolumne River Instream Flow Study — Delaware Reach

Medium Flow- 250 CFS- Benchmark

IMGP0150

September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

Low Flow- 100 CFS- Transect 255A- Looking Across from Head Pin IMGP0889 June 29, 2012

Lower Tuolumne River Instream Flow Study Delaware Reach

Medium Flow- 250 CFS- Transect 255A Looking Across from Head Pin IMGP0157 September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255A
Looking Across from Head Pin

IMGP6395

July 29, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

Low Flow- 100 CFS- Transect 255A-
Looking Downstream from River Left

IMGP0890

June 29, 2012

Lower Tuolumne River Instream Flow Study | Delaware Reach

Medium Flow- 250 CFS- Transect 255A
Looking Downstream from River Left
IMGP0158
September 27, 2011

Lower Tuolumne River Instream Flow Study | Delaware Reach

High Flow- 600 CFS- Transect 255A
Looking Downstream from River Left
IMGP6396
July 29, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

Low Flow- 100 CFS- Transect 255A-
Looking Upstream from River Left
IMGP0891
June 29, 2012

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255A
Looking Upstream from River Left
IMGP6397
July 29, 2011

Lower Tuolumne River Instream Flow Study | Delaware Reach

Low Flow- 100 CFS- Transect 255B- Looking Across from Head Pin | IMGP0886 | June 29, 2012

Lower Tuolumne River Instream Flow Study | Delaware Reach

Medium Flow- 250 CFS- Transect 255B Looking Across from Head Pin | IMGP0154 | September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255B-
Looking Across from Head Pin
IMGP6398
July 29, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

Low Flow- 100 CFS- Transect 255B-
Looking Downstream from River Left
IMGP0888
June 29, 2012

Lower Tuolumne River Instream Flow Study Delaware Reach

Medium Flow- 250 CFS- Transect 255B
Looking Downstream from River Left
IMGP0155
September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255B-
Looking Downstream from River Left
IMGP6399
July 29, 2011

Lower Tuolumne River Instream Flow Study | Delaware Reach

Low Flow- 100 CFS- Transect 255B- Looking Upstream from River Left | IMGP0887 | June 29, 2012

Lower Tuolumne River Instream Flow Study | Delaware Reach

Medium Flow- 250 CFS- Transect 255B- Looking Upstream from River Left | IMGP0156 | September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255B- Looking Upstream from River Left IMGP6400 July 29, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

Low Flow- 100 CFS- Transect 255C- Looking Across from Head Pin IMGP0883 June 29, 2012

Lower Tuolumne River Instream Flow Study Delaware Reach

Medium Flow- 250 CFS- Transect 255C- Looking Across from Head Pin IMGP0151 September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255C- Looking Across from Head Pin IMGP6403 July 29, 2011

Lower Tuolumne River Instream Flow Study

Delaware Reach

Low Flow- 100 CFS- Transect 255C-
Looking Downstream from River Left

IMGP0884

June 29, 2012

Lower Tuolumne River Instream Flow Study

Delaware Reach

Medium Flow- 250 CFS- Transect 255C-
Looking Downstream from River Left

IMGP0152

September 27, 2011

Lower Tuolumne River Instream Flow Study | Delaware Reach

High Flow- 600 CFS- Transect 255C- Looking Downstream from River Left | IMGP6401 | July 29, 2011

Lower Tuolumne River Instream Flow Study | Delaware Reach

Low Flow- 100 CFS- Transect 255C- Looking Upstream from River Left | IMGP0885 | June 29, 2012

Lower Tuolumne River Instream Flow Study Delaware Reach

Medium Flow- 250 CFS- Transect 255C- Looking Upstream from River Left IMGP0153 September 27, 2011

Lower Tuolumne River Instream Flow Study Delaware Reach

High Flow- 600 CFS- Transect 255C- Looking Upstream from River Left IMGP6402 July 29, 2011

Appendix J

Prior PHABSIM Study Comparisons

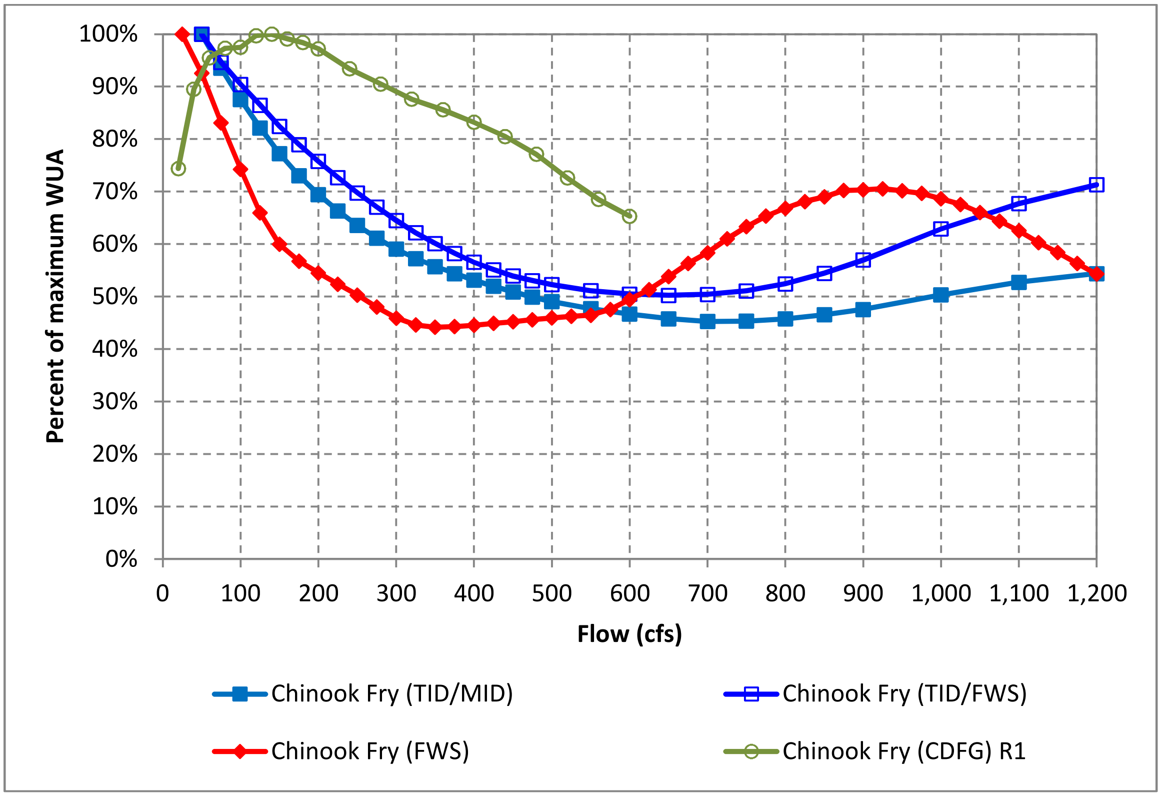


Figure J-1. Chinook salmon fry WUA comparisons to prior instream flow studies on the lower Tuolumne River.

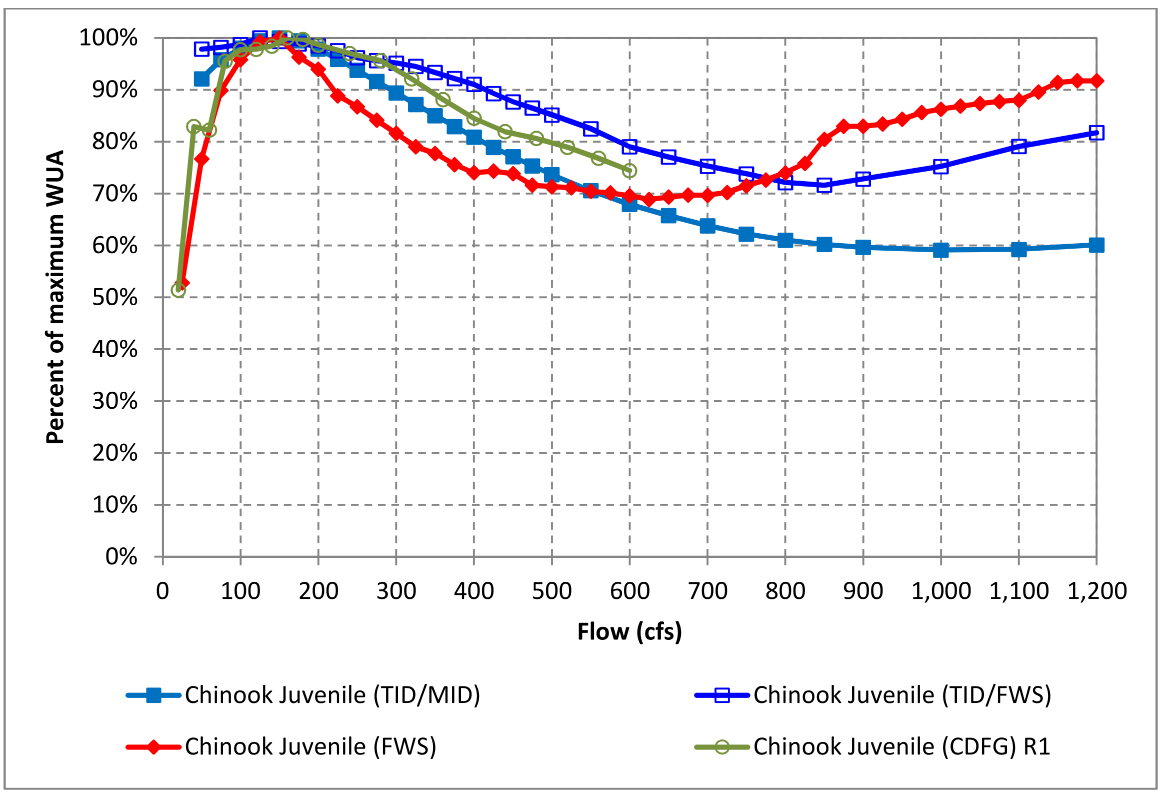


Figure J-2. Chinook salmon juvenile WUA comparisons to prior instream flow studies on the lower Tuolumne River.

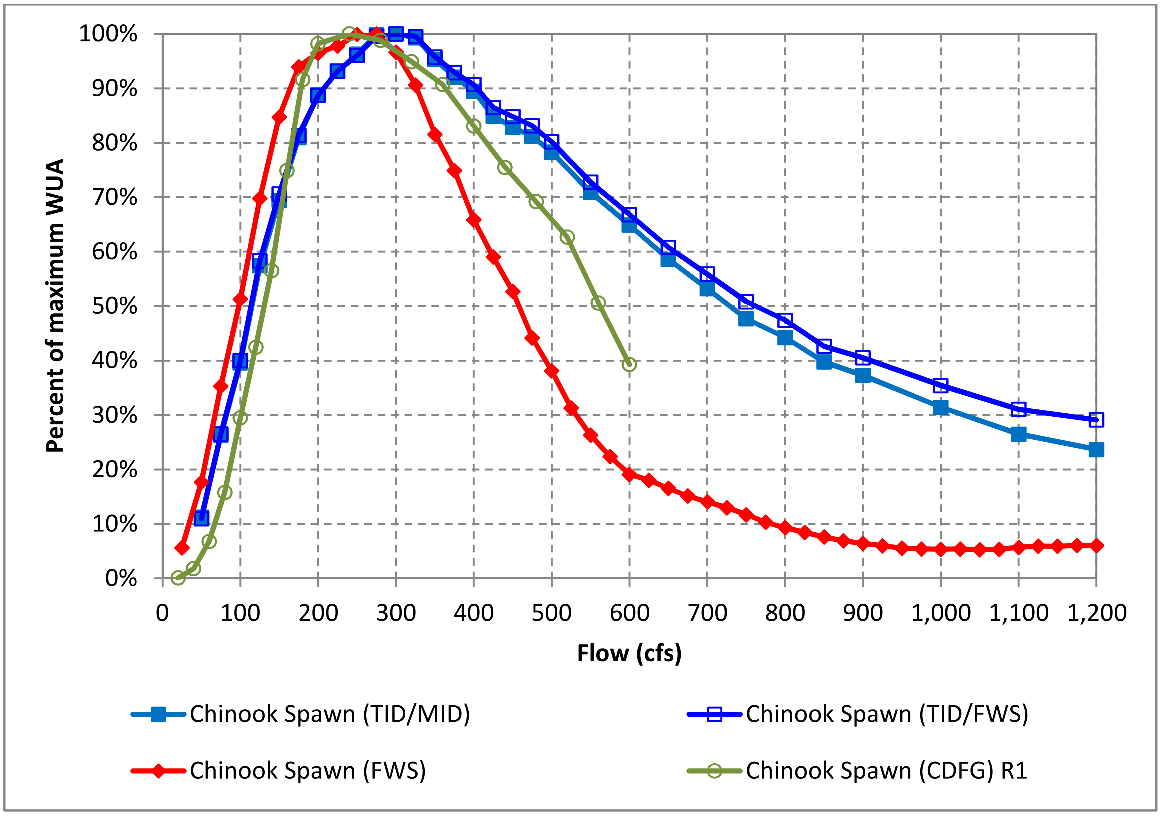


Figure J-3. Chinook salmon spawning WUA comparisons to prior instream flow studies on the lower Tuolumne River.

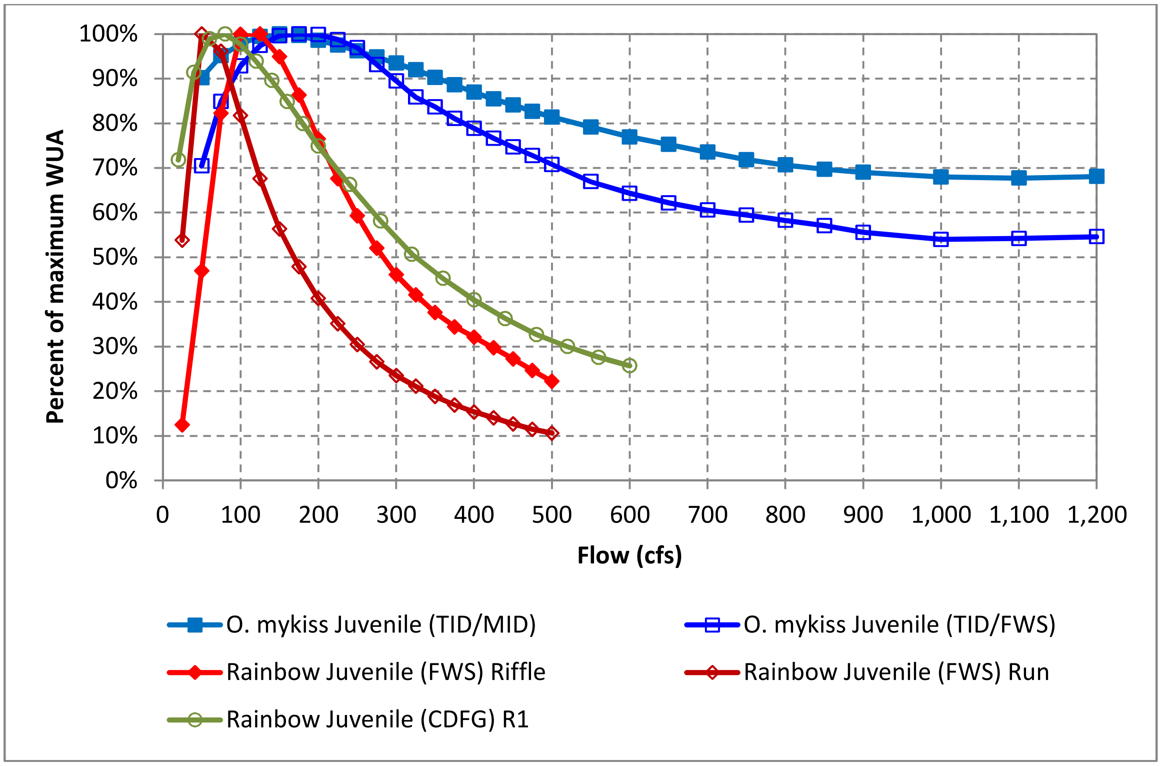


Figure J-4. *O. mykiss* juvenile WUA comparisons to prior instream flow studies on the lower Tuolumne River.

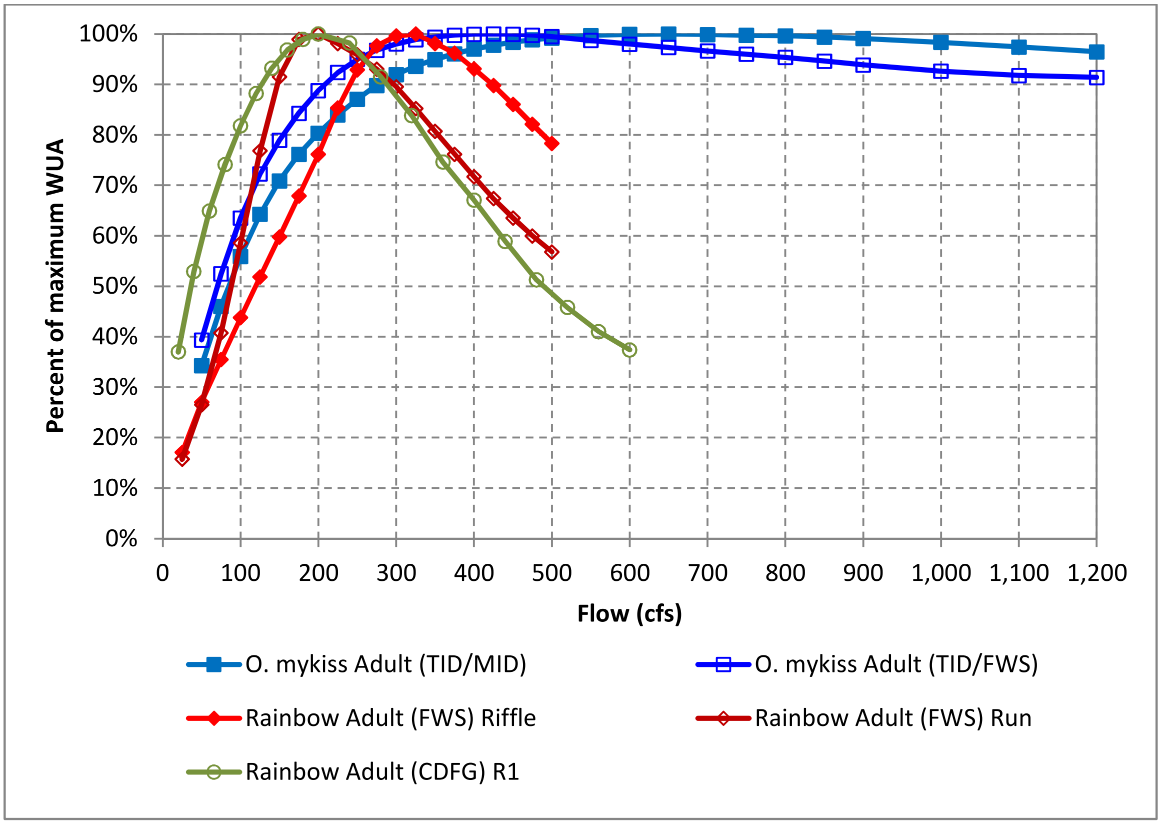


Figure J-5. *O. mykiss* adult WUA comparisons to prior instream flow studies on the lower Tuolumne River

Appendix K

Lower Tuolumne River Instream Flow Study Draft Report Stakeholder Comments and Districts' Reply

From: Scott Wilcox

To: aboucher@bendbroadband.com; agengr6@aol.com; AJensen@bawsca.org; Alison_Willy@fws.gov; anadromous@bendbroadband.com; andreafuller@fishbio.com; Annie Manji <amanji@dfg.ca.gov>; Bill Sears <WSears@sfwater.org>; BParis@olaughlinparis.com; Chris Shutes <blancapaloma@msn.com>; chrissysonke@fishbio.com; Cindy@ccharles.net; Dale Stanton <dstanton@dfg.ca.gov>; deborah_giglio@fws.gov; deltakeep@aol.com; dmarston@dfg.ca.gov; Donn Furman <donn.w.furman@sfgov.org>; elevin@sfwater.org; Eric@tuolumne.org; Erich Gaedeke <Erich.Gaedeke@ferc.gov>; Gantenbein@n-h-i.org; Greg Dias <gregd@mid.org>; Jarvis Caldwell <jarvis.caldwell@hdrinc.com>; jen@riversandwater.com; Jenna Borovansky (jenna.borovansky@hdrinc.com); Jesse.roseman@tuolumne.org; Jessie Raeder <jessie@tuolumne.org>; Jim Hastreiter (james.hastreiter@ferc.gov); jkobrien@dfg.ca.gov; JMEANS@dfg.ca.gov; John J. Devine (john.devine@hdrinc.com); John Wooster <John.Wooster@noaa.gov>; Joy Warren (joyw@mid.org); Karlha@tuolumne.org; Kelleigh Crowe <kelleigh@stillwatersci.com>; kim_webb@fws.gov; Maria Rea <maria.rea@noaa.gov>; Mark_Gard@fws.gov; Michelle_Workman@fws.gov; Monica.Gutierrez@noaa.gov; Noah Hume <noah@stillwatersci.com>; Nsandkulla@bawsca.org; Pat Maloney (pemaloney@TID.ORG); Patrick@tuolumne.org; pbrantley@dfg.ca.gov; Peter Barnes <Peter.Barnes@waterboards.ca.gov>; Ramon_Martin@fws.gov; rmasuda@calwaterlaw.com; rmyoshiyama@ucdavis.edu; Robert W. Hughes <RWHUGHES@dfg.ca.gov>; Russell Liebig <russ@stillwatersci.com>; Scott Wilcox <Scott@stillwatersci.com>; Scott@mcbaintrush.com; Shaara Ainsley <shaaraainsley@fishbio.com>; Steve Boyd (seboyd@tid.org); steve@mlode.com; stsao@dfg.ca.gov; theyne@dfg.ca.gov; Tim O'Laughlin <towater@olaughlinparis.com>; tramirez@sfwater.org; walterw@mid.org; Wayne Swaney <wayne@stillwatersci.com>; Whittaker, John <JWhittaker@winston.com>; William Cowan (wcowan@dfg.ca.gov); wsears@sfwater.org; Zac Jackson (Zachary_Jackson@fws.gov)

Subject: Lower Tuolumne River Instream Flow Study Draft Report is available

Dear Interested Tuolumne River parties:

Per FERC Order dated 16 July 2009 (128 FERC ¶ 61,035), Turlock Irrigation District and Modesto Irrigation District ("Districts") conducted an instream flow study on the lower Tuolumne River that many of you have participated in or been following in one form or another via various workshops, field visits, and correspondence. Initial chapters of the draft report for this study were included in the Initial Study Report (ISR) filed on 17 January 2013 for the relicensing of the Don Pedro Project, and a summary presentation on the study was provided at the ISR meeting on 30 January 2013.

On behalf of the Districts, we are providing the full draft report for your review and comment. It can be downloaded from the following FTP site using the link and access credentials below:

https://files.stillwatersci.com/
Username: Tuolumne13
Password: IFIM2013

Per the study plan, this draft report is being distributed for 30-day agency review. Please provide any comments by COB on Monday, 1 April 2013.

Thank you for your participation and interest in this study.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:

Scott Wilcox
Senior Fisheries Biologist
Stillwater Sciences
279 Cousteau Place, Suite 400
Davis, California 95618

APR 8 2013

Subject: U.S. Fish and Wildlife Service Comments on the February 2013 Draft Report for the Lower Tuolumne River Instream Flow Study, FERC Project P-2299 on the Tuolumne River; Tuolumne and Stanislaus Counties, California

Dear Mr. Wilcox:

The U.S. Fish and Wildlife Service (USFWS or Service) has reviewed the February 2013 Draft Report (Draft Report) for the Lower Tuolumne River Instream Flow Study (Study) and is providing comments herein. The Don Pedro Hydroelectric Project (Project) is licensed by the Federal Energy Regulatory Commission (FERC or Commission), which required the Turlock Irrigation District and Modesto Irrigation District (Districts or TID/MID) to develop and implement the Instream Flow Incremental Methodology Study (IFIM) "to determine instream flows necessary to maximize Chinook salmon [*Oncorhynchus tshawytscha*] and *O. mykiss* [steelhead/rainbow trout] production and survival throughout their various life stages." (Commission Order of July 16, 2009; 128 FERC 61,035). The Tuolumne River IFIM Study Plan submitted on behalf of the Districts was approved with modifications by the Commission on May 12, 2012 (Order Modifying and Approving Instream Flow and Water Temperature Model Study Plans 131 FERC 62,110).

General Comments

The Study fails to meet the stated purpose to determine the instream flows necessary to maximize fall-run Chinook salmon and *O. mykiss* production and survival throughout their various life stages. Smoltification and the survival of juvenile migrants are highly dependent on water temperatures in the lower Tuolumne River (Mesick 2012) and fall pulse flows are needed to minimize straying by migrating adults (Marston *et al.* 2012). Neither of these life history stages was considered in the Study. Flows needed to meet USEPA (2003) water temperature targets for smoltification and outmigrant survival in the river below Modesto as well as adult attraction (Marston *et al.* 2012) should be assessed.

In the December 22, 2011, Study Plan Determination, the Commission staff recommended that the Districts modify their ongoing IFIM study to include an evaluation of Sacramento splittail (*Pogonichthys macrolepidotus*) and Pacific lamprey (*Entosphenus tridentatus*) if existing habitat suitability relationships are available. Despite this recommendation, habitat suitability for these species was not addressed in the Draft Report, although existing habitat suitability relationships for these species are available from the Service. The Service can provide examples of potential habitat suitability relationships for both splittail and Pacific lamprey that were used in the IFIM study for the Merced River Hydroelectric Project (FERC Project 2179) and from the Pacific Northwest (Gard 2009) that should be used for this Study, per the Commission's recommendation.

The July 16, 2009, Commission Order states: "The instream flow study shall also evaluate spring pulse flows of 1,000 to 5,000 cfs and fall pulse flows of up to 1,500 cfs from La Grange Dam." The Draft Report fails to explain how floodplain inundation was analyzed at the higher flows. It appears that only in-channel sampling occurred. The inundated floodplain is important to juvenile Sacramento splittail and salmonid rearing (Feyrer et al 2006, Harrell and Sommer 2003, Jeffres *et al.* 2008, Snider 2001, Snider and Titus 2000, Sommer *et al.* 2001, Sommer *et al.* 2002, Sommer *et al.* 2004a, Sommer *et al.* 2004b, Sommer *et al.* 2008), because the floodplain provides essential food resources for optimal rearing success. The inundated floodplain maximizes production and survival of juvenile salmonids and breeding for Sacramento splittail. Floodplain inundation is so important to early life stages of native riverine fishes that not sampling in the floodplain is inconsistent with conducting a study "to determine instream flows necessary to maximize fall-run Chinook salmon on *O. mykiss* production and survival throughout their various life stages" as required in the Commission Order, or to determine Project effects on the Sacramento splittail as recommended by Commission staff in the Study Plan Determination. The enclosed analysis by the Service of inundation areas on the Tuolumne River (USFWS 2008) is an appropriate and useful reference that was not utilized.

The Draft Report and developed habitat suitability criteria (HSC) fail to take into consideration the importance of cover type. The importance of instream wood and large woody material to salmonid rearing is well understood (Beechie and Sibley 1997, Bilby and Ward 1989, Bryant 1983, Cederholm et al 1997, Crispin *et al.* 1993, Everett and Ruiz 1993, Lemly and Hildebrand 2000, Merz 2001, Senter and Pasternack 2010). Large pieces of wood create both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity, including retention of spawning gravels. Snorkeling observations in the lower Yuba River have found that juvenile Chinook salmon show a strong preference for near-shore habitats with instream woody material (JSA 1992). Access to prey is an essential energetic component of juvenile spring-run Chinook and Central Valley steelhead survival. Juvenile salmonids with access to large woody material and the floodplain are likely to have greater growth and higher survivorship than individual juvenile salmonids that do not have access to this important foraging habitat (Harrell and Sommer 2003).

The added habitat complexity of various cover types provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed (Crispin *et al.* 1993, Lemly and Hilderbrand 2000, Merz 2001). In an October 5, 2009, letter to Tim Ford of Turlock Irrigation District, the Service provided an example of a cover coding system in Table #3 that addresses the different types of cover that are important to analyze (Service's October 5, 2009 letter filed with the Commission as an enclosure to the Service's November 05, 2009 letter). The Service recommended adoption in our October 5, 2009, letter of a cover coding system that includes the following cover types: No cover, cobble, boulder, fine woody vegetation (<1" diameter), fine woody vegetation + overhead, branches, branches + overhead, log (>1' diameter), log + overhead, overhead cover (> 2' above substrate), undercut bank, aquatic vegetation, aquatic vegetation + overhead, and rip-rap. The Districts did not use this cover coding system, instead adopting a system that may not pick up critical distinctions between the types of woody cover and their instream contribution to salmonid and Sacramento spilttail rearing. For example, "branches" are an important spawning component for splittail in the floodplain, so this is a particularly important for the cover category. The collapsing of the cover types into four cover categories further exacerbates the loss of this cover category.

Specific Comments

Section 2, Methods, page 4: The one-dimension (1-D) methodology is not robust and can lead to errors in interpretation. Additionally, the Service is concerned that the one-flow velocity calibration also leads to errors in interpretation. For example, the *O. mykiss* Adult Depth and Velocity Criteria listed in Appendix E are lower than our understanding of optimal depth and velocities in rivers of similar size (*e.g.*, Yuba River) (USFWS 2010a, USFWS 2010b, USFWS 2010c); the *O. mykiss* spawning velocity and depth curves described in Appendix E are lower than the Service's understanding of habitat use collected (USFWSa); and the HSC developed for the *O. mykiss* fry and juveniles are much lower than what is acceptable to the Service. A more accurate methodology would be provided by the HSC developed by the Service for the Yuba River (USFWS 2010a and 2010b) or an equivalent source.

Section 2.4, Calibration Flows, page 8: The Service is of the opinion that the range of flows used in this study is inadequate, because it does not consider a wide range of flows similar to the pattern of the natural hydrograph. The Service recommends a higher range be used (*i.e.*, 300 cfs, 400 cfs, 600 cfs, 1,000 cfs, 1,500 cfs, 2,000 cfs, and 5,000 cfs). This range would give a better idea of how fish respond to higher flows similar to the magnitude of the natural hydrograph.

Section 2.5, Hydraulic Data Collection, page 9: The methods used for collecting the hydraulic data are satisfactory. However, additional data should be collected over a higher range of flows to include inundation of the floodplain to allow for maximum production and survival of salmonids.

Section 2.6, Substrate and Cover Data, page 10 and 11: The use of the modified Wentworth Scale for substrate is acceptable, but the cover categories utilized are not acceptable. Cover and cover-type are critical to salmonids and thus collapsing the measured cover into 4 categories (None, Object Cover, Overhead cover, Both) obscures the importance of this variable. The cover types described in Table 8 of the Draft Report collapse the differentiation of woody material into two sizes. In the Service's October 5, 2009, letter we recommended that woody material be classified as fine woody vegetation (less than one inch in diameter), branches, log (greater than one foot in diameter). Woody material sizes and types are very important as habitat criteria, and further collapsing this variable into "Object Cover" is not appropriate, because salmonids utilize these cover types in different ways and each of these cover types has an important habitat value. Inclusion of "rootwad" is an acceptable addition to the woody material category, but classifying it as overhead cover is likely to obscure the contribution of this type of structure within the river.

Section 2.8, Habitat Time Series, page 14: It is not appropriate to limit the upper range to 1,200 cfs because it takes away the ability to measure and analyze the contribution of the floodplain to salmonid and splittail production and breeding. The range should be extended up to at least 2,000 cfs, to allow for an analysis of the amount of habitat that might be gained at these higher flows. Important fry and juvenile salmonid habitat is provided when flows are high enough to provide cover in the form of submerged riparian vegetation along the riverbanks. It is likely that as flows increase beyond 1,200 cfs, the amount of cover provided by submerged vegetation would substantially increase. Higher flows would likely increase the amount of habitat available and maximize production and survival of the juvenile and adult Chinook salmon and *O. mykiss* due to inundation of areas with better cover and more food throughout their various life stages.

Section 2.9, Effective Habitat, page 15: A standard approach to calculating WUA should be used in conjunction with the "effective" WUA analysis utilized in this study. This is because standard methodologies are well understood and would provide validation (or rejection) of the effective WUA analysis.

The Service supports the use of the temperature model as part of the process of determining the amount of habitat. Water temperature for rearing and migrating juvenile Chinook salmon should be an important part of the analysis; however, "effective" habitat, which includes water temperature suitability, will only be applied to *O. mykiss* and only during the summer. In order to determine instream flows necessary to maximize Chinook salmon and *O. mykiss* production and survival throughout their various life stages, the final study must include an assessment of the flows needed to provide temperatures that support these species. The final study should include an assessment of the flows needed to meet the EPA temperature criteria (2003) for each life stage of Chinook salmon and *O. mykiss*.

Section 2.10, Habitat Suitability Criteria, page 15: The Service does not support the use of the existing curves as originally ordered by the FERC. In its May 12, 2010, Order, the Commission adopted its staff recommendations that "[i]n order to obtain and utilize the most up-to-date information and validate existing data, the Districts should conduct the field work necessary to develop specific HSC curves for the project." (Ordering Paragraph B, adopting staff recommendations in Paragraph 37). The Districts have not followed the Service's recommendation. The Service repeats its recommendation that the Districts use the steelhead curves developed for the Lower American River or from the Lower Yuba River (USFWS 2003, USFWS 2010a).

The Wentworth Scale provided in Appendix A appears to be very similar to the substrate scale recommended by the Service and is likely appropriate for this study.

Section 2.10.1 Existing habitat suitability criteria, page 15: The Service does not support the way the HSC were developed as presented in Table 12. While the spawning criteria for Chinook salmon are acceptable, cover should be included for all the additional categories, along with adjacent velocities for the juvenile and adult Chinook and *O. mykiss*. The Commission's May 12, 2010, Order recognized the value of these attributes, as it ordered the Districts to include measures of cover and adjacent velocity with the other more standard habitat metrics if additional habitat information is collected. (Ordering Paragraph B, adopting staff recommendations in Paragraph 37.)

Section 2.10.1, Site-specific habitat suitability criteria page 16: The approach for collecting HSC for the Chinook salmon and *O. mykiss* adult and juvenile life stages lacks certain aspects that are important. For example, data should have been collected at a different set and range of flows. While we agree with using 2,000 cfs as the maximum flow, the low and mid- range flows should have been higher. The Service recommends a minimum flow of at least 250 cfs, one mid-flow of at least 800 cfs, an additional mid-flow, and a 2,000 cfs maximum flow.

Section 2.10.2.1, Habitat suitability criteria site selection page 17: The Service agrees on the study site selection process. However, areas that have the potential to be inundated must be included in this study in order to develop flows that will maximize fall-run Chinook salmon and *O. mykiss* production and survival throughout their various life stages. The study excluded any dry areas and areas of potential inundation. It is essential that higher flows are included in the study, because the floodplain and habitat subject to potential inundation are very likely to improve and expand the amount of habitat, cover and food that would result in a healthier and more robust Chinook salmon and *O. mykiss* population.

2.10.2.2, Direct Observation and field measurements, page 23: The data collection methods were satisfactory. However, as noted previously, collection of cover data should have been completed. Without cover data, any HSC developed will not be satisfactory. Each cover type has a different contribution to each life stage of the species. Please review reports published by the Service (USFWS 2005, USFWS 2010b) for methods used for collecting HSC data for rearing juvenile *O. mykiss* and adult Chinook salmon.

2.10.2.3, Data Analysis, page 23: The Service agrees with the size ranges assigned to the various life stages, but the categories used for cover are not appropriate (see discussion under Section 3.1.2).

2.10.2.4 Adjacent velocity page 26: The methods used for this aspect of the study are satisfactory for the development of HSC for rearing juvenile salmonids.

Section 3.1.2 Site-specific habitat suitability criteria development and validation, page 26: The Service is supportive of the approach used in this stage of the HSC criteria development. However, additional flows should have been included in the HSC data collection process. As mentioned previously, the Service is in agreement with the 2,000 cfs maximum flow. However, for the low and mid-range flows, we recommend that higher and additional flows be used, with the low flow being at least 250 cfs.

The Service has recommended that cover be used to validate HSC for Chinook salmon and *O. mykiss* fry and juveniles. This is because cover is crucial to the accurate development of juvenile HSC. A full range of meaningful cover variables should be included in the validation process.

The Service does not support the decision to use the depth, mean column velocity curves that were selected, because cover was not included in the analysis, floodplain use was not measured, use at higher flows was not measured, and they appear to be biased toward lower flows. The

"Tuol Mod" curve for the Chinook fry depth and the "Tuol Env" curve for the Chinook fry show that higher flows are most likely desirable for optimal habitat.

Figure 6, page 32: The Service does not support the use of the cover categories shown in Figure 6. We recommend use of the cover categories utilized by the Service (USFWS 2005). The Service's cover categories have been extensively used and have been peer reviewed. Please refer to the Service's peer-reviewed publications that use cover categories for the HSC (USFWS 2005, USFWS 2010b).

Figures 7-9 and 10, 12-17, 19; pages 33-35, 37-41: The HSC do not reflect the most recent understanding of habitat use by Chinook salmon and *O. mykiss*. Juvenile salmonids use the inundated margins and floodplains of rivers during high flows, and this habitat is optimal for production and survival at this life-history stage. Measuring depth and velocity in the margins of the river during low flows and not measuring the velocities and depths associated with the high flows that lead to inundation (adjacent velocities), is likely to misrepresent flows needed for production and survival of Chinook salmon and *O. mykiss*.

Peer-reviewed Service publications (USFWS 2010a, USFWS 2010b, USFWS 2010c) should be used.

Figures 11 and 18, pages 36 and 42: The Service substrate data presented in these figures are appropriate, but the results presented in Figure 18 are not consistent with our understanding of Chinook salmon spawning preference. The Service has found that the size classes of 1-3 inch and 2-4 inch size substrate are optimal for Chinook salmon spawning.

Section 3.1.3, Adjacent velocity, page 33: The Service appreciates the fact that an effort was made to include adjacent velocity as part of the data collection process. Adjacent velocity is important in the development of HSC (USFWS 2010a, USFWS 2010b, USFWS 2010c). We recommend that Service data be included in the process. If the Tuolumne data are insufficient or inadequate, additional data collection is warranted. Peer review of the reports published by the Service has supported the use of adjacent velocity in developing juvenile salmonid HSC.

Section 3.2 Weighted Usable Area, page 45: The Service does not support the WUA results from the PHABSIM analysis for any life stage for Chinook salmon and *O. mykiss*. It is the Service's opinion that there is a strong bias towards lower flows in each case. The collection of criteria data at very low flows and the lack of data collected at higher flows has resulted in the WUA values that were selected. The Districts should review and utilize the WUA values for the Chinook adults and juveniles and the *O. mykiss* juveniles as presented in the Service reports (USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c) and reports published by the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife, and other agencies and parties that concern rivers similar in size to the Tuolumne River.

Section 5 References, pages 60-62: The August 19, 2008, *Flow-Overbank Inundation Relationship for Potential Fall-Run Chinook Salmon and Steelhead/Rainbow Trout Juvenile Outmigration Habitat in the Tuolumne River* (USFWS 2008) was not included as a reference, but it is an important and relevant reference that should be utilized.

The majority of the instream flow references are out-of-date and do not represent the state of the science. The Service recommends utilizing recent literature on instream flow methodology.

Table 16, page 47: The representation of seasonal periodicity in this table is adequate for the purpose of modeling efforts.

Appendix B-1, Target Habitat Types: The habitat types to be sampled are appropriate; however, more units per habitat type should be sampled and doubling the number of units is appropriate.

The proposed habitat units appear acceptable; however, the backup units should also be included and additional transects as recommended by the Service should be added.

Appendix C, Study Background—Field Efforts: It was inappropriate to conduct the HSC surveys at such low flow (*i.e.*, 100 cfs, 350 cfs) and then analyze the HSC data at the high flow of 2,000 cfs. It would have been more appropriate to collect the HSC data at 300 cfs, 400 cfs, 600 cfs, 1,000 cfs, 1,500 cfs, 2,000 cfs, and 5,000 cfs, which would be consistent with the July 16, 2009, Commission Order while allowing for interpretation of floodplain effects.

Appendix C, Methods, Substrate and Cover Data: The substrate data that was used in the PHABSIM model are appropriate; however, the Service does not agree with the cover type categories used in the PHABSIM part of this study. The cover categories used should be based on real data, and an understanding of the cover needs of the species, such as those used in the Service's Instream Flow studies. The cover data are important, in that they are used along with the substrate data to calculate roughness values that are usually used for making adjustments in the roughness values used in calibration (USFWS 2003, USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c).

Appendix C, Habitat Time Series: The range of flows used in the study was inappropriate, considering the potential the river has for higher flows. The Service's flow recommendations for instream flow monitoring are 300 cfs, 400 cfs, 600 cfs, 1,000 cfs, 1,500 cfs, 2,000 cfs, and 5,000 cfs.

Appendix C, Habitat suitability criteria: Serious consideration should be given to reviewing and utilizing the HSC for *O. mykiss* and fall-run Chinook salmon developed by the Service (USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c). The HSC developed by the Service have undergone extensive peer-review and represent the most thorough understanding of the habitat needs of Chinook salmon and *O. mykiss*. Use of HSC that have not undergone such extensive utilization and review may under-represent the flow needs of these species.

Appendix C, Existing habitat suitability criteria data: The criteria used for the habitat suitability criteria data represent a good start. However, adjacent velocity data are also needed as part of development of the HSC data for the fry and juvenile life stages. The cover data collected as part of this study should be used without collapsing the categories. The use of presence/absence data is appropriate.

With regard to the depth and velocity criteria for fall-run Chinook salmon, these criteria are too low. In order to develop adequate HSC, a full range of flows, substrate characteristics, and cover must be used. The small range of low flows, lack of inclusion of multiple cover variables, and lack of measurement of adjacent velocity are all likely to result in low flows that do not meet the needs of Chinook salmon and *O. mykiss* for production and survival. As noted previously, inclusion of the depth and velocity data developed by the Service (USFWS 2003, USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c) would be appropriate.

Appendix D, Chinook Salmon Spawning: The output for depth criteria does not appear to be consistent with our current understanding of habitat use by Chinook salmon. The depth criteria for spawning indicate that very low flows were favored. Based upon our current understanding of habitat use (USFWS 2010a), adult Chinook salmon favor a higher range of depths and velocities.

The Chinook salmon spawning substrate criteria are acceptable. They are very similar to what the Service has used effectively in various studies that have been conducted on a variety of rivers.

Appendix D, Chinook Salmon Juvenile Depth and Velocity Criteria: The Service does not support the use of the criteria developed for the juvenile Chinook salmon. The depth and velocity criteria do not represent the full range of floodplain inundation flows that would support juvenile salmonid production and survival, and appear biased toward lower flows. Cover is the primary component in developing accurate HSC values for juvenile fall-run Chinook. Although cover type and amount are important considerations for juvenile salmonid survival, they were not given adequate consideration in the HSC. The combination of depth, velocity (including adjacent velocity values) and cover are crucial to developing accurate HSC for juvenile Chinook salmon. As stated previously, the reports for the studies conducted by the Service should be reviewed and the existing Service-developed criteria should be utilized.

Appendix D, Chinook Salmon Fry: As described above, cover is a very important component for developing criteria for fry and juvenile Chinook salmon. Depth, velocity (including adjacent velocity), and cover are crucial for developing accurate HSC. Cover is particularly important because the fry and juvenile fish utilize cover to optimize foraging, avoid predation, and reduce the amount of energy expended. Existing criteria developed by the Service should be reviewed and utilized.

Appendix E, O. mykiss Adults: As described in previous comments, the Districts should utilize the HSC for *O. mykiss* that were developed by the Service in studies conducted on the Lower Yuba River (USFWS 2010a).

Although the Service supports the use of a variety of curves from various studies, in this case, the HSC for *O. mykiss* (steelhead) developed by the Service should be utilized. The adult *O. mykiss* criteria that are presented in the Draft Report appear to be biased toward lower velocities and depths. Higher flows need to be considered and analyzed, because higher flows may allow for higher amounts of food that can be utilized by the adult *O. mykiss*. In addition, the HSC should include cover, which is crucial for the adult fish.

Appendix E, O. mykiss Spawning: The data appear to show a bias toward lower flows, depths, and velocities, which is not consistent with the results in other studies conducted by the Service (USFWS 2010a).

The use of the substrate size presented in the Draft Report is acceptable.

Appendix E, O. mykiss Fry: The Service's HSC should be utilized in this study, as the Service's criteria data for *O. mykiss* fry have been collected in a number of robust studies in rivers and creeks in the Central Valley (USFWS 2010b, USFWS 2010c).

Appendix E, O. mykiss Juveniles: A proper and accurate HSC for *O. mykiss* juveniles should utilize depth, velocity (including adjacent velocity) and cover.

Appendix F, Chinook salmon fry: The Service is supportive of the velocity and depth HSC developed in this case. However, it best to consider the primary use of the criteria developed by the Service. The data for depth and velocity appear very similar for the "Tuol Mod" and Yuba (USFWS 2010b), so these criteria are likely appropriate.

With regard to the velocity suitability, "Tuol ENV" suitability criteria presented in the Chinook salmon fry table, the Service is not supportive of its use. These criteria are strongly biased toward lower velocities and flows. The use of Service's suitability criteria for Chinook salmon fry from the various studies conducted should be used. As noted previously, there are several reports from the Service that provide the criteria needed.

As noted previously, the use of adjacent velocities and cover is crucial to developing accurate criteria for fry and juvenile Chinook salmon fry.

Appendix F, O. mykiss Fry: The Service is not supportive of the criteria. The depth and velocity data are severely biased toward lower flows and velocities. Given the potential for more habitat associated with higher flows that can inundate areas that have good quality cover and food, higher flows should be considered in the analysis. Again, as described previously, adjacent velocities and cover are crucial to developing accurate HSC for *O. mykiss* fry.

Appendix F, O. mykiss Adult: It is the Service's opinion that the velocity and depth criteria that are presented in this report are inadequate as they do not consider higher flows. As described previously, higher flows could result in habitat inundation, which could result in a higher level of food and cover for the fish. This food and cover is expected to result in better survival, larger fish, and high production values for the fish. Cover should be included in the development of the adult HSC. It is recommended that the Districts use the HSC developed by the Service for the Yuba River, Clear Creek and any other rivers/creeks where juvenile steelhead/rainbow trout HSC were developed, as these data should provide the HSC characteristics that are similar to those required by adults. Review of the reports published by the Service, NMFS, California Department of Fish and Wildlife and other agencies and stakeholders is recommended.

Conclusion

The Service requests that our peer-reviewed HSC be used in the Study. If you have any questions regarding this response, please contact Deborah Giglio of my staff at (916) 414-6600.

Sincerely,

Daniel Welsh
Assistant Field Supervisor

Enclosures

cc: Kimberly Bose, Secretary, FERC
FERC #2299 Service List, Don Pedro Hydroelectric Project
John Devine DTA
Peter Barnes, SWRCB
Walter Ward, Modesto Irrigation District
Greg Dias, Modesto Irrigation District
William Johnston, Modesto Irrigation District

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Pursuant to the requirements of the FERC Order, the Lower Tuolumne River Instream Flow Study Draft Report was circulated for a 30-day review period (February 28, 2013 – April 1, 2013) to the resource agencies and interested parties (Appendix K-1). Following the 30-day review period, the USFWS provided comments on April 8, 2013 (Appendix K-2), which have been addressed in this final report. No other comments were received as of the date of this filing. Additional analyses, resulting from information provided by the USFWS in their April 8, 2013 letter and subsequent to the FERC December 22, 2011 relicensing Study Plan Determination, will be reported separately as described in the body of this report.

No.	USFWS comment	Districts' reply
General comments		
1	The Study fails to meet the stated purpose to determine the instream flows necessary to maximize fall-run Chinook salmon and *0. mykiss* production and survival throughout their various life stages. Smoltification and the survival of juvenile migrants are highly dependent on water temperatures in the lower Tuolumne River (Mesick 2012) and fall pulse flows are needed to minimize straying by migrating adults (Marston *et al.* 2012). Neither of these life history stages was considered in the Study. Flows needed to meet USEPA (2003) water temperature targets for smoltification and outmigrant survival in the river below Modesto as well as adult attraction (Marston *et al.* 2012) should be assessed.	The proposed methods for fulfilling the purpose of the study were detailed in the study plan filed with the Commission on October 14, 2009, and approved, pursuant to Ordering paragraphs (A) through (E) of the Commission's May 12, 2010 order. The study plan was followed during implementation of the study. Water temperature conditions are being addressed as part of relicensing study W&AR-14 (*Temperature Criteria Assessment*); the flow/water temperature assessment component of the study will be completed following the completion and review of study W&AR-16 (*Lower Tuolumne River Temperature Model*) and will subsequently be filed in conjunction with the Draft License Application. A 2D hydraulic model of over-bank flows up to 5,000 cfs was developed as part of the Pulse Flow Study report submitted on June 18, 2012 (Stillwater Sciences 2012).[1] Although an assessment of water temperature variations during spring and fall pulse flows is provided, assessment of either adult attraction flows or outmigrant survival was not included in the approved study plan (Stillwater Sciences 2009). A fall pulse flow is already provided under the current flow regime.
2	In the December 22, 2011, Study Plan Determination, the Commission staff recommended that the Districts modify their ongoing IFIM study to include an evaluation of Sacramento splittail *(Pogonichthys macrolepidotus)* and Pacific lamprey *(Entosphenus tridentatus)* if existing habitat suitability relationships are available. Despite this recommendation, habitat suitability for these species was not addressed in the Draft Report, although existing habitat suitability relationships for these species are available from the Service. The Service can provide examples of potential habitat suitability relationships for both	The Lower Tuolumne River Instream Flow Studies Study Plan (Stillwater Sciences 2009), including the development of an IFIM study, was filed with the Commission on October 14, 2009. The Study Plan was approved, pursuant to Ordering paragraphs (A) through (E) of the Commission's May 12, 2010 order. The December 22, 2011 FERC Relicensing Study Plan Determination expanded the study to include splittail and Pacific lamprey using available HSC, if available. The USFWS provided available HSC in their April 8, 2013 comment letter. The Districts will review the HSC for conformance with the same screening criteria applied to other HSC used for this study (including an assessment of applicability

[1] Stillwater Sciences. 2012. Lower Tuolumne River Instream Flow Studies: Pulse Flow Study Report. Prepared by Stillwater Sciences, Berkeley, California for Turlock Irrigation District and Modesto Irrigation District, California. June

No.	USFWS comment	Districts' reply
	splittail and Pacific lamprey that were used in the IFIM study for the Merced River Hydroelectric Project (FERC Project 2179) and from the Pacific Northwest (Gard 2009) that should be used for this Study, per the Commission's recommendation.	to the Tuolumne River, and if applicable, will include an additional assessment. Contrary to the USFWS' inference, the Commission did not specify particular HSC that "should be used for this Study." Due to the timing of the HSC availability, and that this additional analysis was recommended as part of FERC's Study Plan Determination during relicensing, the assessment will be conducted and reported separately.
3	The July 16, 2009, Commission Order states: "The instream flow study shall also evaluate spring pulse flows of 1,000 to 5,000 cfs and fall pulse flows of up to 1,500 cfs from La Grange Dam." The Draft Report fails to explain how floodplain inundation was analyzed at the higher flows. It appears that only in-channel sampling occurred. The inundated floodplain is important to juvenile Sacramento splittail and salmonid rearing (Feyrer et al 2006, Harrell and Sommer 2003, Jeffres *et al.* 2008, Snider 2001, Snider and Titus 2000, Sommer *et al.* 2001, Sommer *et al.* 2002, Sommer *et al.* 2004a, Sommer *et al.* 2004b, Sommer *et al.* 2008), because the floodplain provides essential food resources for optimal rearing success. The inundated floodplain maximizes production and survival of juvenile salmonids and breeding for Sacramento splittail. Floodplain inundation is so important to early life stages of native riverine fishes that not sampling in the floodplain is inconsistent with conducting a study "to determine instream flows necessary to maximize fall-run Chinook salmon on *O. mykiss* production and survival throughout their various life stages" as required in the Commission Order, or to determine Project effects on the Sacramento splittail as recommended by Commission staff in the Study Plan Determination. The enclosed analysis by the Service of inundation areas on the Tuolumne River (USFWS 2008) is an appropriate and useful reference that was not utilized.	In order to examine the broad flow ranges identified in the FERC July 16, 2009 Order, the Study Plan separated the study into two separate investigations. This conventional one-dimensional (1D) PHABSIM study, which examines in-channel habitat conditions at flows from approximately 100 cfs up to 1,000 cfs, and a 2D hydraulic model of over-bank flows up to 5,000 cfs developed as part of the Pulse Flow Study report (Stillwater Sciences 2012). As referenced in the IFIM Report, *"Separate from the IFIM study component of the Study Plan, a Pulse Flow Study Report was submitted on June 18, 2012".* The Pulse Flow Study report included development of a 2D hydraulic model to assess the habitat suitability at in-channel locations as well as adjacent overbank areas for flows of 1,000–5,000 cfs. It should be noted, however, that most of the studies cited by the USFWS refer to floodplains that bear little or no resemblance to channel conditions in the Tuolumne River, and the results of the studies should be interpreted accordingly. Additionally, USFWS has not cited any site-specific empirical data or studies to support the hypothesis it offers concerning Tuolumne River floodplain rearing.

No.	USFWS comment	Districts' reply
4	The Draft Report and developed habitat suitability criteria (HSC) fail to take into consideration the importance of cover type. The importance of instream wood and large woody material to salmonid rearing is well understood (Beechie and Sibley 1997, Bilby and Ward 1989, Bryant 1983, Cederholm et al1997, Crispin *et al.* 1993, Everett and Ruiz 1993, Lemly and Hildebrand 2000, Merz 2001, Senter and Pasternack 2010). Large pieces of wood create both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity, including retention of spawning gravels. Snorkeling observations in the lower Yuba River have found that juvenile Chinook salmon show a strong preference for near-shore habitats with instream woody material (JSA 1992). Access to prey is an essential energetic component of juvenile spring-run Chinook and Central Valley steelhead survival. Juvenile salmonids with access to large woody material and the floodplain are likely to have greater growth and higher survivorship than individual juvenile salmonids that do not have access to this important foraging habitat (Harrell and Sommer 2003).	No consistent and complementary cover criteria data from other sources were identified by the technical workgroup participants. During the February 3, 2011 HSC Workshop (Appendix F of the Draft Report), the group discussed the idea of using existing cover codes. Because of limited availability of published cover HSC and wide variation in codes and sample sizes, it was decided to collect additional site-specific data during field surveys in 2011, and investigate adapting information from other coding systems. Existing curves from the Yuba River and Clear Creek were presented by USFWS. The applicability, complexity, and sample size of the various cover code data were discussed. Possible use of Sacramento River cover codes was discussed, although the data were not presented or reviewed. The decision resulting from the consultation meetings was that the Districts would consider combining cover coding systems from various sources into a simplified cover code that could potentially have sufficient observations in each cover category to be reasonably applicable. The draft report presented such a coding system, and applied the cover criteria for species and life stages with sufficient observations, as described below. Fish cover availability was collected in the field during the IFIM and HSC site-specific field surveys and were applied for life stages with a sufficient sample size (i.e., n>150). Cover included 10 categories (recorded in the field as percent cover); however, initial analyses identified no discernible relationships for HSC preference using all 10 categories. In order to increase sample size and provide more meaningful results, cover types were grouped into four categories: • No Cover: (1) no available cover • Object Cover: (2) cobble, (3) boulder, (4) fine woody debris, (5) large woody debris • Overhead Cover: (6) overhanging vegetation, (7) aquatic vegetation, (8) undercut bank, (9) rootwad, and (10) water surface turbulence • Both: a combination of both overhead cover and object cover Site-specific cover HSC was applied where the number of observations were sufficient (i.e., >150). Additionally, a sensitivity analysis was completed and reported in Section 4.1.3: "In order to evaluate the effect of the cover parameter on the WUA results, the model was run both with and without cover for Chinook fry. The results presented in Appendix H (Figure H-3) suggest that cover has a relatively small influence in the magnitude of WUA, and no influence on the WUA versus flow relationship." Therefore, the flow model results were not greatly altered by the inclusion of cover, and is not anticipated to change with the

No.	USFWS comment	Districts' reply
		inclusion of alternate cover categories; the WUA curve shape and peaks remained the same, even though the magnitude of the curves varied.
5	The added habitat complexity of various cover types provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed (Crispin *et al.* 1993, Lemly and Hilderbrand 2000, Merz 2001). In an October 5, 2009, letter to Tim Ford of Turlock Irrigation District, the Service provided an example of a cover coding system in Table #3 that addresses the different types of cover that are important to analyze (Service's October 5, 2009 letter filed with the Commission as an enclosure to the Service's November 05, 2009letter). The Service recommended adoption in our October 5, 2009, letter of a cover coding system that includes the following cover types: No cover, cobble, boulder, fine woody vegetation (<1" diameter), fine woody vegetation+ overhead, branches, branches+ overhead, log (>1' diameter), log+ overhead, overhead cover(> 2' above substrate), undercut bank, aquatic vegetation, aquatic vegetation + overhead, and rip-rap. The Districts did not use this cover coding system, instead adopting a system that may not pick up critical distinctions between the types of woody cover and their instream contribution to salmonid and Sacramento spilttail rearing. For example, "branches" are an important spawning component for splittail in the floodplain, so this is a particularly important for the cover category. The collapsing of the cover types into four cover categories further exacerbates the loss of this cover category.	See reply to USFWS Comment No. 4.

No.	USFWS comment	Districts' reply
Specific comments		
6	*Section* 2, *Methods, page* 4: The one-dimension (1D) methodology is not robust and can lead to errors in interpretation. Additionally, the Service is concerned that the one-flow velocity calibration also leads to errors in interpretation. For example, the *O. mykiss* Adult Depth and Velocity Criteria listed in Appendix E are lower than our understanding of optimal depth and velocities in rivers of similar size *(e.g.,* Yuba River) (USFWS 2010a, USFWS 2010b, USFWS 2010c); the *O. mykiss* spawning velocity and depth curves described in Appendix E are lower than the Service's understanding of habitat use collected (USFWSa); and the HSC developed for the *O. mykiss* fry and juveniles are much lower than what is acceptable to the Service. A more accurate methodology would be provided by the HSC developed by the Service for the Yuba River (USFWS 2010a and 20 l0b) or an equivalent source.	This study was conducted in compliance with the Study Plan approved by FERC, pursuant to Ordering paragraphs (A) through (E) of the Commission's May 12, 2010 order, and consistent with additional elements of the December 22, 2011 Study Plan Determination for related relicensing studies. The study was designed and implemented by an interagency workgroup as an objective, scientific, and empirical analysis of flow-habitat relationships. Critical components of the study were developed in consultation with the USFWS and other stakeholders; the Districts held a series of workshops and meetings covering initial study planning, habitat typing, site selection and transect placement, habitat suitability criteria (HSC) development, and model calibration (the workshop summaries were provided in Appendices A–F). The Service's data from various other rivers, in addition to many other data sources, were considered by the group during development of the HSC. Additionally, the workgroup included site-specific HSC validation surveys for certain species and lifestages. The validation efforts allowed for evaluation of each of the targeted species and life stages selected for validation (Chinook salmon fry and juvenile; *O. mykiss* fry, juvenile, and adult). In total, five of the species life stages were considered validated by the site-specific results and two curves were expanded. There were no HSC curves constricted by the results of the site-specific surveys.
7	*Section* 2.4, *Calibration Flows, page* 8: The Service is of the opinion that the range of flows used in this study is inadequate, because it does not consider a wide range of flows similar to the pattern of the natural hydro graph. The Service recommends a higher range be used (i*.e.,* 300 cfs, 400 cfs, 600 cfs, 1,000 cfs, 1,500 cfs, 2,000 cfs, and 5,000 cfs). This range would give a better idea of how fish respond to higher flows similar to the magnitude of the natural hydrograph.	See reply to USFWS Comment No. 3.
8	*Section* 2.5, *Hydraulic Data Collection, page* 9: The methods used for collecting the hydraulic data are satisfactory. However, additional data should be collected over a higher range of flows to include inundation of the floodplain to allow for maximum production and survival of salmonids.	See reply to USFWS Comment No. 3.

No.	USFWS comment	Districts' reply
9	*Section 2.6, Substrate and Cover Data, page 10 and 11:* The use of the modified Wentworth Scale for substrate is acceptable, but the cover categories utilized are not acceptable. Cover and cover-type are critical to salmonids and thus collapsing the measured cover into 4 categories (None, Object Cover, Overhead cover, Both) obscures the importance of this variable. The cover types described in Table 8 of the Draft Report collapse the differentiation of woody material into two sizes. In the Service's October 5, 2009, letter we recommended that woody material be classified as fine woody vegetation (less than one inch in diameter), branches, log (greater than one foot in diameter). Woody material sizes and types are very important as habitat criteria, and further collapsing this variable into "Object Cover" is not appropriate, because salmonids utilize these cover types in different ways and each of these cover types has an important habitat value. Inclusion of "rootwad" is an acceptable addition to the woody material category, but classifying it as overhead cover is likely to obscure the contribution of this type of structure within the river.	See reply to USFWS Comment No. 4.
10	*Section 2.8, Habitat Time Series, page 14:* **It** is not appropriate to limit the upper range to 1,200 cfs because it takes away the ability to measure and analyze the contribution of the floodplain to salmonid and splittail production and breeding. The range should be extended up to at least 2,000 cfs, to allow for an analysis of the amount of habitat that might be gained at these higher flows. Important fry and juvenile salmonid habitat is provided when flows are high enough to provide cover in the form of submerged riparian vegetation along the riverbanks. It is likely that as flows increase beyond 1,200 cfs, the amount of cover provided by submerged vegetation would substantially increase. Higher flows would likely increase the amount of habitat available and maximize production and survival of the juvenile and adult Chinook salmon and *O. mykiss* due to inundation of areas with better cover and more food throughout their various life stages.	See reply to USFWS Comment No. 3.

No.	USFWS comment	Districts' reply
11	*Section 2.9, Effective Habitat, page 15:* A standard approach to calculating WUA should be used in conjunction with the "effective" WUA analysis utilized in this study. This is because standard methodologies are well understood and would provide validation (or rejection) of the effective WUA analysis.	The WUA results presented in the Draft IFIM report were developed using "standard" methods, in accordance with the FERC order. The effective WUA analysis based upon temperature suitability of various river segments has not yet be completed, as described in Section 2.9 of the Draft Report, pending completion of the relicensing study W&AR-16 (*Lower Tuolumne River Temperature Model*).
12	The Service supports the use of the temperature model as part of the process of determining the amount of habitat. Water temperature for rearing and migrating juvenile Chinook salmon should be an important part of the analysis; however, "effective" habitat, which includes water temperature suitability, will only be applied to *O. mykiss* and only during the summer. In order to determine instream flows necessary to maximize Chinook salmon and *O. mykiss* production and survival throughout their various life stages, the final study must include an assessment of the flows needed to provide temperatures that support these species. The final study should include an assessment of the flows needed to meet the EPA temperature criteria (2003) for each life stage of Chinook salmon and *O. mykiss*.	See reply to USFWS Comment No. 11 regarding effective habitat. The effective habitat analysis will be conducted consistent with the FERC-approved Study Plan. The December 22, 2011 Study Plan Determination stated that EPA (2003) temperature criteria will be used by FERC staff in their evaluation of project effects "unless empirical evidence from the lower Tuolumne River is provided that suggests different criteria are appropriate for salmonids in the lower Tuolumne River." However, assessment of flows to meet EPA temperature criteria was not part of the FERC Order for this study. Once completed, the *Lower Tuolumne River Temperature Model* (W&AR-16) may be used to evaluate flows to meet various water temperature targets. In addition, studies W&AR-6 and W&AR-10 (salmon and steelhead modeling) include water temperature as part of the analysis.
13	*Section 2.10, Habitat Suitability Criteria, page 15:* The Service does not support the use of the existing curves as originally ordered by the FERC. In its May 12, 2010, Order, the Commission adopted its staff recommendations that "[i]n order to obtain and utilize the most up-to-date information and validate existing data, the Districts should conduct the field work necessary to develop specific HSC curves for the project." (Ordering Paragraph B, adopting staff recommendations in Paragraph 37). The Districts have not followed the Service's recommendation. The Service repeats its recommendation that the Districts use the steelhead curves developed for the Lower American River or from the Lower Yuba River (USFWS 2003, USFWS 2010a).	See reply to USFWS Comment No. 6.
14	The Wentworth Scale provided in Appendix A appears to be very similar to the substrate scale recommended by the Service and is likely appropriate for this study.	Comment noted.

No.	USFWS comment	Districts' reply
15	*Section 2.10.1 Existing habitat suitability criteria, page 15:* The Service does not support the way the HSC were developed as presented in Table 12. While the spawning criteria for Chinook salmon are acceptable, cover should be included for all the additional categories, along with adjacent velocities for the juvenile and adult Chinook and *O. mykiss.* The Commission's May 12, 2010, Order recognized the value of these attributes, as it ordered the Districts to include measures of cover and adjacent velocity with the other more standard habitat metrics if additional habitat information is collected. (Ordering Paragraph B, adopting staff recommendations in Paragraph 37.)	See reply to USFWS Comment No. 4 and No. 6 regarding cover and HSC development. Additionally, adjacent velocities were evaluated for all lifestages included in the site-specific surveys, which included juvenile Chinook salmon and juvenile and adult *O. mykiss*. The FERC-approved IFIM study did not include adult Chinook salmon HSC (except for spawning), since such evaluations would not be relevant. The results are included in Section 3.1.3 of the Draft Report. However, as noted in the report, the adjacent velocity assessment indicated that there is limited application of adjacent velocity methods to lower Tuolumne River conditions (in part due to the scale of the river); the differences in mean column velocity were small (0.06 to 0.25 fps) between occupied and adjacent areas, suggesting limited use (or lack) of well-developed shear zones or feeding lanes (which is consistent with more homogenous morphological and hydraulic conditions observed in the Tuolumne or other large alluvial valley rivers). In addition, the magnitude of the adjacent velocities was well within the preferred velocity ranges (e.g., suitability indices of >0.5) for continuous occupation of the point location (i.e., the adjacent velocity was within a velocity range typical of positions more continuously occupied by the species and life stage).
16	*Section 2.10.1, Site-specific habitat suitability criteria page 16:* The approach for collecting HSC for the Chinook salmon and *O. mykiss* adult and juvenile life stages lacks certain aspects that are important. For example, data should have been collected at a different set and range of flows. While we agree with using 2,000 cfs as the maximum flow, the low and mid- range flows should have been higher. The Service recommends a minimum flow of at least 250 cfs, one mid-flow of at least 800 cfs, an additional mid-flow, and a 2,000 cfs maximum flow.	HSC site-specific surveys were conducted during February, March, May, and July at 100 cfs, 350 cfs, and 2,000 cfs. The range of months and flows allowed for surveys under various conditions, across seasons, and included habitats added under high flows, such as over-bank and side-channel habitats. Additionally, 100 cfs is included in the range of flows surveyed during the IFIM study; it is unclear why USFWS would want to omit data at lower flows and only collect it at higher flows, as this would introduce bias into the results. The Districts see no benefit for repeating the surveys at alternate flows within the same range. Specific flows for collection of HSC data were not specified in the FERC-approved Study Plan, nor recommended by the Service during any of the numerous workshops on related subjects.

No.	USFWS comment	Districts' reply
17	*Section 2.10.2.1, Habitat suitability criteria site selection page* 17: The Service agrees on the study site selection process. However, areas that have the potential to be inundated must be included in this study in order to develop flows that will maximize fall-run Chinook salmon and *O. mykiss* production and survival throughout their various life stages. The study excluded any dry areas and areas of potential inundation. It is essential that higher flows are included in the study, because the floodplain and habitat subject to potential inundation are very likely to improve and expand the amount of habitat, cover and food that would result in a healthier and more robust Chinook salmon and *O. mykiss* population.	See reply to USFWS Comment No. 3 and No. 16. Additionally, areas that have the potential to be inundated were included in the HSC site-specific surveys during the 2,000 cfs effort; 36 over-bank terrace quadrats and 76 side-channel quadrats (a portion inundated under higher flow conditions) were included in the surveys (see Table 13 of the Draft Report).
18	*2.10.2.2, Direct Observation and field measurements, page 23:* The data collection methods were satisfactory. However, as noted previously, collection of cover data should have been completed. Without cover data, any HSC developed will not be satisfactory. Each cover type has a different contribution to each life stage of the species. Please review reports published by the Service (USFWS 2005, USFWS 2010b) for methods used for collecting HSC data for rearing juvenile *O. mykiss* and adult Chinook salmon.	See reply to USFWS Comment No. 4.
19	*2.10.2.3, Data Analysis, page 23:* The Service agrees with the size ranges assigned to the various life stages, but the categories used for cover are not appropriate (see discussion under Section 3.1.2).	See reply to USFWS Comment No. 4.
20	*2.10.2.4 Adjacent velocity page 26:* The methods used for this aspect of the study are satisfactory for the development of HSC for rearing juvenile salmonids.	Comment noted.
21	*Section 3.1.2 Site-specific habitat suitability criteria development and validation, page 26:* The Service is supportive of the approach used in this stage of the HSC criteria development. However, additional flows should have been included in the HSC data collection process. As mentioned previously, the Service is in agreement with the 2,000 cfs maximum flow. However, for the low and mid-range flows, we recommend that higher and additional flows be used, with the low flow being at least 250 cfs.	See reply to USFWS Comment No. 16.

No.	USFWS comment	Districts' reply
22	The Service has recommended that cover be used to validate HSC for Chinook salmon and *O. mykiss* fry and juveniles. This is because cover is crucial to the accurate development of juvenile HSC. A full range of meaningful cover variables should be included in the validation process.	See reply to USFWS Comment No. 4.
23	The Service does not support the decision to use the depth, mean column velocity curves that were selected, because cover was not included in the analysis, floodplain use was not measured, use at higher flows was not measured, and they appear to be biased toward lower flows. The "Tuol Mod" curve for the Chinook fry depth and the "Tuol Env" curve for the Chinook fry show that higher flows are most likely desirable for optimal habitat.	Cover data was collected during the field surveys (See reply to USFWS Comment No. 4). Over-bank habitat (floodplain) was surveyed during the Pulse-Flow Study (See reply to USFWS Comment No. 3), and the HSC site-specific surveys (See reply to USFWS Comment No. 16 and 17). The inclusion of cover (or not) is unrelated to the depth and velocity curves. Also, this comment is inconsistent with other USFWS comments. Please see USFWS's Comment No. 50, which states that, for "Chinook salmon fry: The Service is supportive of the velocity and depth HSC developed in this case." Additionally, the relationship of habitat to flow is indicated by the WUA versus flow results, and not solely or directly by evaluation of HSC curves.
24	*Figure 6, page 32:* The Service does not support the use of the cover categories shown in Figure 6. We recommend use of the cover categories utilized by the Service (USFWS 2005). The Service's cover categories have been extensively used and have been peer reviewed. Please refer to the Service's peer-reviewed publications that use cover categories for the HSC (USFWS 2005, USFWS 2010b).	See reply to USFWS Comment No. 4.
25	*Figures 7-9 and 10,12-17, 19; pages 33-35,37-41:* The HSC do not reflect the most recent understanding of habitat use by Chinook salmon and *O mykiss*. Juvenile salmonids use the inundated margins and floodplains of rivers during high flows, and this habitat is optimal for production and survival at this life-history stage. Measuring depth and velocity in the margins of the river during low flows and not measuring the velocities and depths associated with the high flows that lead to inundation (adjacent velocities), is likely to misrepresent flows needed for production and survival of Chinook salmon and *O mykiss*.	The selection and validation process of HSC was designed and implemented by an interagency workgroup as an objective, scientific, and empirical analysis of flow-habitat relationships. The HSC site-specific surveys were conducted at flows ranging between 100 cfs and 2,000 cfs, which inundated over-bank habitat (See also reply to USFWS Comment No. 16 and 17). The hydraulic model was developed using mid-flow calibration velocities (not low flows) when the active channel was inundated. Adjacent velocity was also measured and reported; however, the point of the Service's reference to "adjacent velocities" in relation to "high flows that lead to inundation" is unclear (See also reply to USFWS Comment No. 15).

No.	USFWS comment	Districts' reply
26	Peer-reviewed Service publications (USFWS 2010a, USFWS 2010b, USFWS 2010c) should be used.	Comment noted
27	*Figures 11 and 18, pages 36 and 42:* The Service substrate data presented in these figures are appropriate, but the results presented in Figure 18 are not consistent with our understanding of Chinook salmon spawning preference. The Service has found that the size classes of 1-3 inch and 2-4 inch size substrate are optimal for Chinook salmon spawning.	The HSC presented in Figure 18 represent *O. mykiss* spawning substrate suitability preference. Figure 11 includes spawning substrate suitability preference for Chinook salmon, which appears to be in line with the USFWS understanding.
28	*Section 3.1.3, Adjacent velocity, page 33:* The Service appreciates the fact that an effort was made to include adjacent velocity as part of the data collection process. Adjacent velocity is important in the development of HSC (USFWS 2010a, USFWS 2010b, USFWS 2010c). We recommend that Service data be included in the process. If the Tuolumne data are insufficient or inadequate, additional data collection is warranted. Peer review of the reports published by the Service has supported the use of adjacent velocity in developing juvenile salmonid HSC.	Adjacent velocity was surveyed and evaluated for each species and life stages included in the Lower Tuolumne River site-specific surveys (total obs =570), which was sufficient to produce statistically valid results; however, as noted in Sect. 3.1.3, the habitat conditions and use by various species and life stages within the Lower Tuolumne indicated that the magnitude of the adjacent velocities was well within the velocity range typical of positions occupied by the species and life stage (see also reply to USFWS Comment No. 15). The largest significant difference between mean column velocity and adjacent velocity was 0.25 fps (Chinook juveniles). As a result, there appears to be limited application of adjacent velocity analytical methods to lower Tuolumne River conditions.
29	*Section 3.2 Weighted Usable Area, page 45:* The Service does not support the WUA results from the PHABSIM analysis for any life stage for Chinook salmon and *O. mykiss*. It is the Service's opinion that there is a strong bias towards lower flows in each case. The collection of criteria data at very low flows and the lack of data collected at higher flows has resulted in the WUA values that were selected. The Districts should review and utilize the WUA values for the Chinook adults and juveniles and the *O. mykiss* juveniles as presented in the Service reports (USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c) and reports published by the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife, and other agencies and parties that concern rivers similar in size to the Tuolumne River.	The instream flow study was designed and implemented by a collaborative workgroup including agency (USFWS, CDFG, etc.) and other stakeholders, as an objective, scientific, and empirical analysis of flow-habitat relationships using data collected over a range of flows. As such, the results are based on the collected data, and not opinion. The site-specific HSC data collection occurred at a range of flows, between 100 cfs and 2,000 cfs (see also reply to USFWS Comment No. 16 and 17). HSC data from the USFWS, NMFS, and CDFG was incorporated into the interagency workgroup discussions, and in some cases, was included in the selected HSC curves (see Appendices A-F of the Draft Report). Additionally, WUA is a model result based on considerable underlying data collected using standard methods, and is not "selected" by anyone. Using "WUA values for the Chinook adults and juveniles and the O. mykiss juveniles as presented in the Service reports" from other rivers would not be appropriate, as FERC ordered an instream flow study to determine WUA for the Tuolumne River. Lastly, the results of the two prior Lower Tuolumne River instream flow studies conducted by the USFWS and CDFG (USFWS 1995 and CDFG 1981) produced comparable results to this study (see section 4.2, *Comparison to Prior PHABSIM Study Results*, of the Draft Report).

No.	USFWS comment	Districts' reply
30	*Section 5 References, pages 60-62:* The August 19, 2008, *Flow-Overbank Inundation Relationship for Potential Fall-Run Chinook Salmon and Steelhead/Rainbow Trout Juvenile Outmigration Habitat in the Tuolumne River* (USFWS 2008) was not included as a reference, but it is an important and relevant reference that should be utilized.	A discussion comparing the results of the USFWS (2008) GIS analysis with 2D modeling conducted as part of the Pulse Flow Study (Stillwater Sciences 2012) was previously completed and included in Section 4.1.1 of that report
31	The majority of the instream flow references are out-of-date and do not represent the state of the science. The Service recommends utilizing recent literature on instream flow methodology.	This study was conducted in compliance with the Study Plan approved by FERC, pursuant to Ordering paragraphs (A) through (E) of the Commission's May 12, 2010 order. Additional information was considered, and in some cases, incorporated by the workgroup. Comparisons to prior studies on the Lower Tuolumne River, including the USFWS 1995 IFIM Report, were also incorporated into the report and are believed informative to the results. Prior Service comments regarding "state of the science" were previously addressed by FERC during the study planning phase.
32	*Table 16, page* 47: The representation of seasonal periodicity in this table is adequate for the purpose of modeling efforts.	Comment noted
33	*Appendix B-1, Target Habitat Types:* The habitat types to be sampled are appropriate; however, more units per habitat type should be sampled and doubling the number of units is appropriate.	As noted in the *Lower Tuolumne River Instream Flow Study Site Selection Meeting Summary* (Appendix B-1), two USFWS representatives participated in the study site selection workshop, and USFWS staff participated in transect selection. The study was conducted in accordance with the workshop direction, and USFWS staff concurred on the number and placement of transects (Appendix B-2, Attachment 1).
34	The proposed habitat units appear acceptable; however, the backup units should also be included and additional transects as recommended by the Service should be added.	As noted in the *Lower Tuolumne River Instream Flow Study Site Selection Meeting Summary* (Appendix B-1), "backup" units were selected near the randomly selected sites …in order to provide more options during field transect selection, in the event that an originally selected random unit was less acceptable for some reason (access, hydraulics, logistics, habitat characteristics, etc.). The field surveys were completed at transects placed during the Lower Tuolumne River Instream Flow Study. Transect Placement (see Appendix B-2), or according to the direction of the workgroup. See also response to USFWS Comment 33 above regarding USFWS staff previously concurring to the number and placement of transects.

No.	USFWS comment	Districts' reply
35	*Appendix* C, *Study Background-Field Efforts:* It was inappropriate to conduct the HSC surveys at such low flow *(i.e.,* 100 cfs, 350 cfs) and then analyze the HSC data at the high flow of 2,000 cfs. It would have been more appropriate to collect the HSC data at 300 cfs, 400 cfs, 600 cfs, 1,000 cfs, 1,500 cfs, 2,000 cfs, and 5,000 cfs, which would be consistent with the July 16, 2009, Commission Order while allowing for interpretation of floodplain effects.	Site-specific HSC surveys were conducted at a range of flows between 100 cfs and 2,000 cfs, which covers the full range of in-channel flows the 1D study was modeling. Excluding low flows from the analysis would result in a bias in the data, as described in the response to USFWS Comment No. 16.
36	*Appendix* C, *Methods, Substrate and Cover Data:* The substrate data that was used in the PHABSIM model are appropriate; however, the Service does not agree with the cover type categories used in the PHABSIM part of this study. The cover categories used should be based on real data, and an understanding of the cover needs of the species, such as those used in the Service's Instream Flow studies. The cover data are important, in that they are used along with the substrate data to calculate roughness values that are usually used for making adjustments in the roughness values used in calibration (USFWS 2003, USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c).	See reply to USFWS Comment No. 4
37	*Appendix* C, *Habitat Time Series:* The range of flows used in the study was inappropriate, considering the potential the river has for higher flows. The Service's flow recommendations for instream flow monitoring are 300 cfs, 400 cfs, 600 cfs, 1,000 cfs, 1,500 cfs, 2,000 cfs, and 5,000 cfs.	See reply to USFWS Comment No. 3
38	*Appendix* C, *Habitat suitability criteria:* Serious consideration should be given to reviewing and utilizing the HSC for ***O.*** *mykiss* and fall-run Chinook salmon developed by the Service (USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c). The HSC developed by the Service have undergone extensive peer-review and represent the most thorough understanding of the habitat needs of Chinook salmon and ***O.*** *mykiss.* Use of HSC that have not undergone such extensive utilization and review may under-represent the flow needs of these species.	See reply to USFWS Comment No. 6

No.	USFWS comment	Districts' reply
39	*Appendix* C, *Existing habitat suitability criteria data:* The criteria used for the habitat suitability criteria data represent a good start. However, adjacent velocity data are also needed as part of development of the HSC data for the fry and juvenile life stages. The cover data collected as part of this study should be used without collapsing the categories. The use of presence/absence data is appropriate.	See reply to USFWS Comment No. 15 and No. 28 regarding the application of adjacent velocity in the Lower Tuolumne River IFIM model. See also reply to USFWS Comment No. 4 regarding the use of cover HSC.
40	With regard to the depth and velocity criteria for fall-run Chinook salmon, these criteria are too low. In order to develop adequate HSC, a full range of flows, substrate characteristics, and cover must be used. The small range of low flows, lack of inclusion of multiple cover variables, and lack of measurement of adjacent velocity are all likely to result in low flows that do not meet the needs of Chinook salmon and *O. mykiss* for production and survival. As noted previously, inclusion of the depth and velocity data developed by the Service (USFWS 2003, USFWS 2005, USFWS 2010a, USFWS 2010b, USFWS 2010c) would be appropriate.	The site-specific HSC data collection occurred at a range of flows between 100 cfs and 2,000 cfs (see also reply to USFWS Comment No. 16 and No. 17). See reply to USFWS Comment No. 4 regarding the inclusion of cover HSC. See reply to USFWS Comment No. 15 and No. 28 regarding adjacent velocity measurements.
41	*Appendix D, Chinook Salmon Spawning:* The output for depth criteria does not appear to be consistent with our current understanding of habitat use by Chinook salmon. The depth criteria for spawning indicate that very low flows were favored. Based upon our current understanding of habitat use (USFWS 2010a), adult Chinook salmon favor a higher range of depths and velocities.	The Chinook spawning criteria were based on CDFG's 1982 site-specific data from the Lower Tuolumne River. It was found to be appropriate for use by the workgroup September 20, 2010 (Draft Report Appendix D).
42	The Chinook salmon spawning substrate criteria are acceptable. They are very similar to what the Service has used effectively in various studies that have been conducted on a variety of rivers.	Comment noted.

No.	USFWS comment	Districts' reply
43	*Appendix D, Chinook Salmon Juvenile Depth and Velocity Criteria:* The Service does not support the use of the criteria developed for the juvenile Chinook salmon. The depth and velocity criteria do not represent the full range of floodplain inundation flows that would support juvenile salmonid production and survival, and appear biased toward lower flows. Cover is the primary component in developing accurate HSC values for juvenile fall-run Chinook. Although cover type and amount are important considerations for juvenile salmonid survival, they were not given adequate consideration in the HSC. The combination of depth, velocity (including adjacent velocity values) and cover are crucial to developing accurate HSC for juvenile Chinook salmon. As stated previously, the reports for the studies conducted by the Service should be reviewed and the existing Service-developed criteria should be utilized.	The site-specific HSC data collection occurred at a range of flows between 100 cfs and 2,000 cfs and included flooded overbank and side-channel habitats (see also reply to USFWS Comment No. 16 and No. 17). Cover data was collected and applied where able (see also reply to USFWS Comment No. 4). Adjacent velocity was collected and included in the analysis (see also reply to USFWS Comment No. 15 and No. 28).
44	*Appendix D, Chinook Salmon Fry:* As described above, cover is a very important component for developing criteria for fry and juvenile Chinook salmon. Depth, velocity (including adjacent velocity), and cover are crucial for developing accurate HSC. Cover is particularly important because the fry and juvenile fish utilize cover to optimize foraging, avoid predation, and reduce the amount of energy expended. Existing criteria developed by the Service should be reviewed and utilized.	See reply to USFWS Comment No. 4 and No. 6.
45	*Appendix E, O. mvkiss Adults:* As described in previous comments, the Districts should utilize the HSC for *O. mykiss* that were developed by the Service in studies conducted on the Lower Yuba River (USFWS 2010a).	See reply to USFWS Comment No. 6.
46	Although the Service supports the use of a variety of curves from various studies, in this case, the HSC for *O. mykiss* (steelhead) developed by the Service should be utilized. The adult *O. mykiss* criteria that are presented in the Draft Report appear to be biased toward lower velocities and depths. Higher flows need to be considered and analyzed, because higher flows may allow for higher amounts of food that can be utilized by the adult *O. mykiss*. In addition, the HSC should include cover, which is crucial for the adult fish.	See reply to USFWS Comment No. 6 regarding HSC curve selection. See reply to USFWS Comment No. 3 regarding study flows. See reply to USFWS Comment No. 4 regarding cover HSC.

No.	USFWS comment	Districts' reply
47	*Appendix E, O. mykiss Spawning:* The data appear to show a bias toward lower flows, depths, and velocities, which is not consistent with the results in other studies conducted by the Service (USFWS 2010a). The use of the substrate size presented in the Draft Report is acceptable.	The instream flow study was designed and implemented by an interagency workgroup as an objective, scientific, and empirical analysis of flow-habitat relationships; the Service provides no data or analysis indicating the results are biased. Comparing flow results to another river is inappropriate, since this study was ordered and conducted for the Tuolumne River. In fact, the results are consistent with a prior instream flow study conducted by the Service for the Tuolumne River (and another study of the Tuolumne River by CDFG) (USFWS 1995 and CDFG 1981).
48	*Appendix E, O. mykiss Fry:* The Service's HSC should be utilized in this study, as the Service's criteria data for *O. mykiss* fry have been collected in a number of robust studies in rivers and creeks in the Central Valley (USFWS 2010b, USFWS 2010c).	See reply to USFWS Comment No. 47 and No. 6.
49	*Appendix E, O. mykiss Juveniles:* A proper and accurate HSC for *O. mykiss* juveniles should utilize depth, velocity (including adjacent velocity) and cover.	As noted in reply to USFWS Comment No. 15, adjacent velocities were evaluated for all lifestages included in the site-specific surveys, which included *O. mykiss* juveniles. See reply to USFWS Comment No. 4 regarding cover HSC.
50	*Appendix F, Chinook salmon* fry: The Service is supportive of the velocity and depth HSC developed in this case. However, it best to consider the primary use of the criteria developed by the Service. The data for depth and velocity appear very similar for the "Tuol Mod" and Yuba (USFWS 2010b), so these criteria are likely appropriate.	Comment noted.
51	With regard to the velocity suitability, "Tuol ENV" suitability criteria presented in the Chinook salmon fry table, the Service is not supportive of its use. These criteria are strongly biased toward lower velocities and flows. The use of Service's suitability criteria for Chinook salmon fry from the various studies conducted should be used. As noted previously, there are several reports from the Service that provide the criteria needed.	See reply to USFWS Comment No. 6.
52	As noted previously, the use of adjacent velocities and cover is crucial to developing accurate criteria for fry and juvenile Chinook salmon fry.	See reply to USFWS Comment No. 4, No. 6, No. 15, and No. 28.

No.	USFWS comment	Districts' reply
53	*Appendix F, O. mykiss Fry:* The Service is not supportive of the criteria. The depth and velocity data are severely biased toward lower flows and velocities. Given the potential for more habitat associated with higher flows that can inundate areas that have good quality cover and food, higher flows should be considered in the analysis. Again, as described previously, adjacent velocities and cover are crucial to developing accurate HSC for *O. mykiss* fry.	See reply to USFWS Comment No. 6 regarding criteria development. See reply to USFWS Comment No. 3 regarding study flows. See reply to USFWS Comment No. 4, No. 15, and No. 28 regarding cover and adjacent velocity.
54	*Appendix F, O. mykiss Adult*: It is the Service's opinion that the velocity and depth criteria that are presented in this report are inadequate as they do not consider higher flows. As described previously, higher flows could result in habitat inundation, which could result in a higher level of food and cover for the fish. This food and cover is expected to result in better survival, larger fish, and high production values for the fish. Cover should be included in the development of the adult HSC. It is recommended that the Districts use the HSC developed by the Service for the Yuba River, Clear Creek and any other rivers/creeks where juvenile steelhead/rainbow trout HSC were developed, as these data should provide the HSC characteristics that are similar to those required by adults. Review of the reports published by the Service, NMFS, California Department of Fish and Wildlife and other agencies and stakeholders is recommended.	See reply to USFWS Comment No. 6 regarding criteria development and Comment No. 4 regarding cover. Data were collected at low, mid, and very high flows (i.e., up to 2,000 cfs). Additionally, the Districts included the referenced HSC developed by the Service for the Yuba River and Clear Creek along with numerous other streams in the inter-agency HSC workshops (please refer to the workshop summaries in Appendices D–F). The selected curves were subsequently validated or expanded based on the site-specific Lower Tuolumne HSC survey results.
Conclusion		
55	The Service requests that our peer-reviewed HSC be used in the Study. If you have any questions regarding this response, please contact Deborah Giglio of my staff at (916) 414-6600.	As noted in the reply to USFWS Comment No. 6, the Service participated in study development and their HSC data were considered during selection of appropriate HSC for the Tuolumne River.