



TECHNICAL MEMORANDUM 3-4

INSTREAM FLOW - MERCED RIVER BETWEEN MERCED FALLS DAM AND CROCKER-HUFFMAN DIVERSION DAM

Merced River Hydroelectric Project
FERC Project No. 2179

March 2011

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INTERIM TECHNICAL MEMORANDUM 3-4

Executive Summary

In 2010, in support of relicensing its Merced River Hydroelectric Project FERC Project No. 2179 (Project), Merced Irrigation District (Merced ID) conducted an instream flow study in the 3-mile-long section of the Merced River from Pacific Gas and Electric Company's (PG&E) Merced Falls Dam to the non-Project Crocker-Huffman Diversion Dam using the United States Department of Interior, Fish and Wildlife Service's (USFWS)-developed one-dimensional Physical Habitat Simulation (PHABSIM) model.

The study focused on Pacific lamprey (*Lampetra tridentate*), Kern Brook lamprey (*Lampetra hubbsi*), rainbow trout (*Oncorhynchus mykiss*), Sacramento sucker (*Catostomus occidentalis*), riffle sculpin (*Cottis gulosus*) and prickly sculpin (*Cottis asper*). The specific objectives of the study were to estimate habitat index versus flow relationships for the target fishes using a PHABSIM model, as well as to develop habitat duration analyses to predict fish habitat over time under existing flow conditions and unimpaired flow conditions. It was expected that the model, outside of the study, would be used to estimate flow/habitat relationships for potential alternative stream flow scenarios.

In February 2010, Merced ID, in collaboration with Relicensing Participants, selected 25 PHABSIM transects. Nineteen transects were selected in the riverine sub-reach, which extends from the base of Merced Falls Dam 1.26 miles downstream to the upper limit of the Crocker-Huffman Diversion Dam impoundment. Six transects were selected in the impoundment sub-reach, which extends 1.74 miles downstream to the face of the Crocker-Huffman Diversion Dam.

Merced ID consulted with Relicensing Participants regarding lamprey Habitat Suitability Criteria (HSC), and on July 29, 2010, filed with FERC collaboratively agreed to lamprey HSC.

PHABSIM hydraulic and habitat data were collected at four discharges: 252 cfs, 774 cfs, 2,112 cfs and 3,309 cfs. Velocity measurements were collected at 2,112 cfs at 19 transects and at 774 cfs at six transects. Additional velocity measurements were made in edge/margin habitats on all 25 transects during the release of 3,309 cfs.

Merced ID consulted with Relicensing Participants regarding the PHABSIM modeling, HEC-RAS modeling and Habitat Duration Analysis (HDA) parameters on two conference calls, January 7, 2011 and February 16, 2011.

Weighted Usable Area (WUA) was calculated for both the riverine and impounded sub-reaches for target species/lifestages. An HDA was conducted for the riverine sub-reach by water year, month, species/lifestage, and hydrologic node for modeled existing flow conditions (Base Case) and synthesized unimpaired flow conditions for the period of record (Water Years 1969 through 2006). An HDA was not performed for the impoundment sub-reach because of its static nature (e.g., stable stage).

There were two variances to the FERC-approved Instream Flow between PG&E's Merced Falls Dam and Crocker-Huffman Diversion Dam Study (Study 3.4). First, the study fell slightly behind the FERC-approved study schedule due to delayed substrate data collection. Substrate data were collected in November 2010 when flows were low and the water clear enough for data collection. Second, during the February 16, 2011 conference call, Relicensing Participants agreed that WUA should be calculated, but that it was unnecessary to run the habitat duration analysis in the impoundment sub-reach.

The study is complete.

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List of Attachments

- Attachment 3-4A PHABSIM Transect Photos – Low Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 3.8MB; 30 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4B PHABSIM Transect Photos - Mid Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 7.2MB; 36 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4C PHABSIM Transect Photos - High Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 13.7MB; 58 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4D PHABSIM Transect Photos – High High Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 9.7MB; 48 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4E Part 1 - PHABSIM Riverine sub-reach hydraulic model calibration reports. [1 Adobe pdf file: 9.7MB; 48 pages formatted to print double sided on 8 ½ x 11 paper]
- Part 2 – HEC-RAS Impoundment sub-reach hydraulic model [1 Adobe pdf file: 355 kB; 11 pages formatted to print double sided on 8 ½ x 11 paper, 9 pages formatted to print single sided on 11 x 17.]
- Attachment 3-4F Habitat Analytical Tool for the Merced River Below Merced Falls [Available on DVD]

TECHNICAL MEMORANDUM 3-4

Instream Flow¹

Merced Irrigation District's (Merced ID or Licensee) continued operation and maintenance (O&M) of the existing Merced River Hydroelectric Project, FERC Project No. 2179 (Project), may affect fish habitat in the Merced River between Pacific Gas & Electric's (PG&E) Merced Falls Dam (FERC Project No. 2467) and the non-Project Crocker-Huffman Diversion Dam.

1.0 Goals and Objectives

The goal of this study was to develop a flow-habitat model for fish in the section of the Merced River from PG&E's Merced Falls Dam to the non-Project Crocker-Huffman Diversion Dam.

The specific objectives of the study were to estimate habitat index versus flow relationships for fish using a one-dimensional (1D) Physical Habitat Simulation (PHABSIM) (Milhous et al. 1981) model developed by the United States Department of Interior, Fish and Wildlife Service (USFWS) and develop habitat duration analyses (HDA) to predict fish habitat over time under unimpaired and existing stream flows.²

2.0 Methods

2.1 Study Area

The geographic extent of the study area was the 3-mile long section of the Merced River between Merced Falls Dam and Crocker-Huffman Diversion Dam (i.e., the reach). Merced ID segmented the reach into two sub-reaches based on stream hydraulics. The first segment was the 1.26-mile long riverine (i.e., swift flowing) portion of the Merced River from the base of Merced Falls Dam to the upper limit of the Crocker-Huffman Diversion Dam impoundment. The second segment was the 1.74-mile long impoundment (i.e., slow moving) portion of the Merced River that is impounded by the Crocker-Huffman Diversion Dam. Figure 2.1-1 shows the distribution of PHABSIM transects in each sub-reach.

¹ This technical memorandum presents the results of the FERC-approved Study 3-4, Instream Flow in the Merced River Between Merced Falls Dam and Crocker-Huffman Diversion Dam.

² It was expected that the model may be used to estimate flow/habitat relationships for potential alternative stream flow scenarios, but these analysis would be performed outside of the FERC-approved study.

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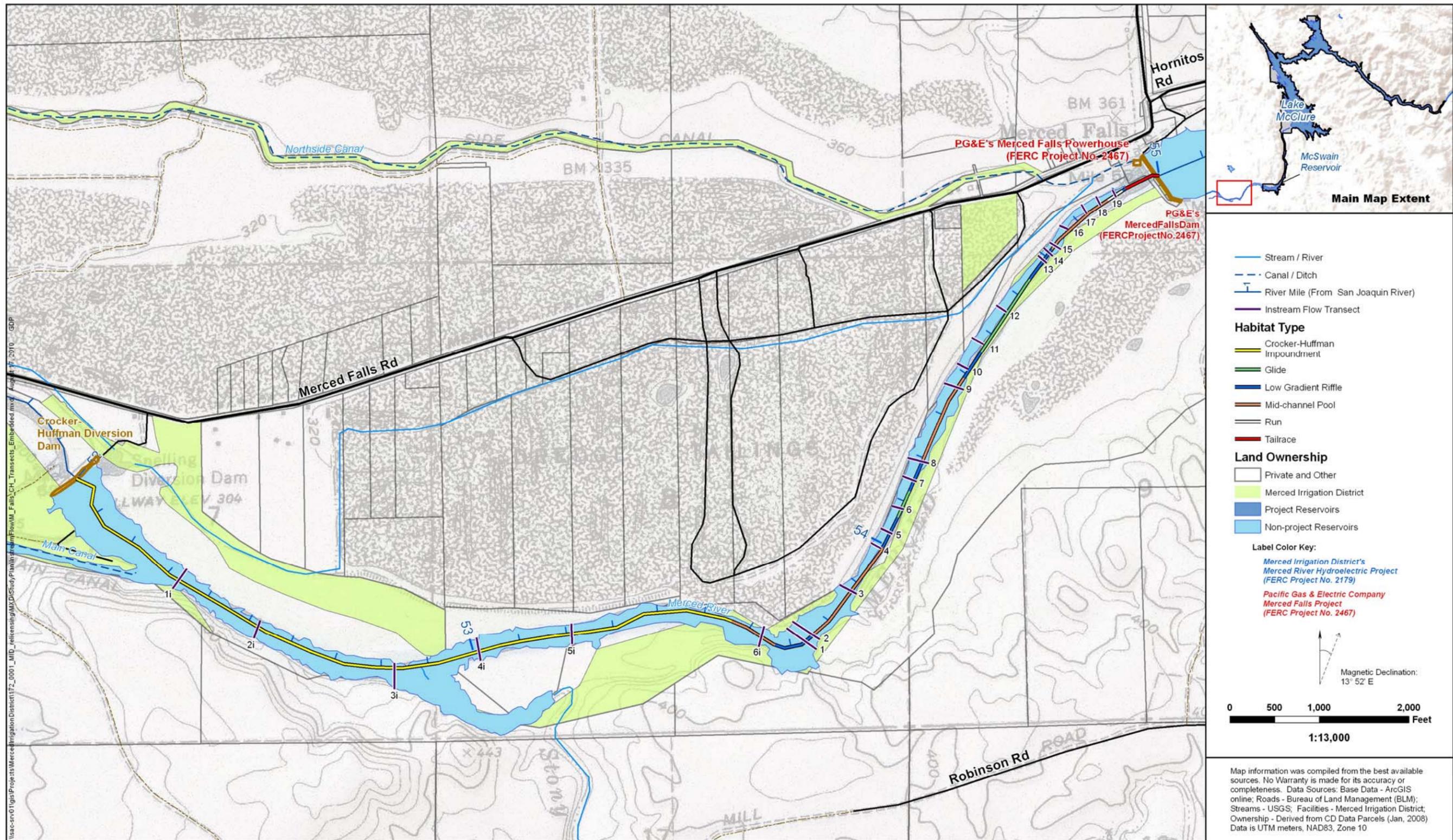


Figure 2.1-1. PHABSIM study area showing transect locations. Transect numbers 1i to 6i denote transects placed in the impoundment sub-reach.

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2.2 Study Methods

Merced ID used the PHABSIM method to model the response of fish habitat to flow in the reach. PHABSIM is the most widely accepted and applied fish habitat model in California and across the United States. It is the most frequently used model for rivers with simple channel structure, rivers with non-peaking hydro regulation, and in rivers inhabited by species without complex habitat/life history requirements. These factors are consistent with this FERC-approved study.

Physical habitat and hydraulic parameters were measured and modeled using a combination of standard techniques developed by the USFWS and United States Geological Survey (USGS) (Trihey and Wegner 1981; Bovee 1982; Bovee 1997; Bovee et al. 1998; Rantz 1982).

The study was performed in seven steps 1) selecting target species, life stages and habitat suitability criteria (HSC), 2) selecting calibration flows, 3) mapping meso-habitats, 4) selecting transects, 5) collecting field data, 6) modeling hydraulic and habitat conditions, and 7) developing a HDA. The methods used to perform each of these are described below.

2.2.1 Step 1 - Target Species, Life Stages, Habitat Suitability Criteria and Periodicity

Two of the six fish species known or suspected to occur in the reach were divided into two guilds based on habitat preference. The two guilds were lamprey (*Lampetra* spp), and sculpin (*Cottus* spp.). The lamprey guild was comprised of two species; Pacific lamprey (*Lampetra tridentate*)³ and Kern Brook lamprey (*Lampetra hubbsi*). The sculpin guild was comprised of two species; riffle sculpin (*Cottis gulosus*) and prickly sculpin (*Cottis asper*). Rainbow trout (*Oncorhynchus mykiss*) and Sacramento sucker (*Catostomus occidentalis*) were also identified as target species. Table 2.2-1 summarizes the species, lifestages, and corresponding HSC chosen for the study.

Table 2.2-1. Summary of guilds, represented species, target life stages and corresponding HSCs used in study.

Species or Guild	Common Name	Scientific Name	Life Stages	Habitat Suitability Criteria
Lamprey	Pacific lamprey	<i>Lampetra tridentate</i>	Ammocoete and Adult Spawning	Close et al. (2002) and Gard (2009) were used in development of the lamprey ammocoete HSC, while Gunckel et al. (2009) was used in the development of HSC for the adult spawning lifestage of lamprey.
	Kern Brook lamprey	<i>Lampetra hubbsi</i>		
Rainbow Trout	Rainbow trout	<i>Oncorhynchus mykiss</i>	Spawning	Rainbow trout spawning HSCs used in Nevada Irrigation District's (NID) Yuba-Bear Hydroelectric Project (FERC Project No. 2266) relicensing and Pacific Gas and Electric Companies (PG&E) Drum-Spaulding Project (FERC Project No. 2310) relicensing, both on the Yuba and Bear rivers in California. U.S. Fish and Wildlife Service (2004), for adult and juvenile rainbow trout, and (2008) for fry rainbow trout.
			Fry	
			Juvenile	
			Adult	
Sacramento Sucker	Sacramento sucker	<i>Catostomus occidentalis</i>	Juvenile	Sacramento sucker juvenile and adult HSCs used in NID's Yuba-Bear Hydroelectric Project relicensing and PG&E's Drum-Spaulding Project relicensing, both on the Yuba and Bear rivers in California.
			Adult	

³ Merced ID believes that it is problematic at best regarding whether Pacific lamprey, an anadromous fish, occurs in the study reach. However, Merced ID agreed to include Pacific lamprey in the analysis.

Table 2.2-1. (continued)

Species or Guild	Common Name	Scientific Name	Life Stages	Habitat Suitability Criteria
Sculpin	Riffle sculpin	<i>Cottus gulosus</i>	Combined Juvenile and Adult	Combined sculpin juvenile and adult HSC used in PG&E's Spring Gap-Stanislaus Project (FERC Project No. 2130) relicensing, and Tri-Dam's Beardsley/Donnells Project (FERC Project No. 2005) relicensing, both on the Stanislaus River in California.
	Prickly sculpin	<i>Cottus asper</i>		

2.2.1.1 Habitat Suitability

HSC define the range of conditions that a particular species lifestage may inhabit. Variables typically defined with HSC curves include depth, velocity, instream cover and bottom substrate. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively, for a species/lifestage. The HSC provide the biological criteria input to the PHABSIM hydraulic model that converts physical habitat simulation data into a habitat suitability index (i.e., WUA) for evaluation of various flow scenarios on the particular species and lifestage(s) of interest.

The HSC used in this FERC-approved study are presented in Tables 2.2-2 to 2.2-10 and Figures 2.2-1 through 2.2-23. Note that substrate was only considered a variable for rainbow trout spawning habitat simulations; for all other species/life stages, all substrates were considered fully suitable (i.e., suitability was set equal to 1.0).

Rainbow Trout

Licensee used HSC recommended by USFWS in USFWS's January 26, 2010 letter to Merced ID. These include USFWS (2004) for adult and juvenile rainbow trout, and USFWS (2008) for fry rainbow trout.

For spawning, Licensee used recently developed curves for use in large rivers (i.e., widths >150 feet) in Nevada Irrigation District's Yuba-Bear Hydroelectric Project (FERC Project No. 2266) and PG&E's Drum-Spaulling Project (FERC Project No. 2310). Both of the relicensings are on the Yuba and Bear rivers in California.

Table 2.2-2. Rainbow trout adult HSC. USFWS 2004.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability
Adult	0.03	0.00	0.80	0.00
	0.04	0.19	0.90	0.12
	0.10	0.23	1.00	0.15
	0.20	0.30	1.25	0.23
	0.30	0.38	1.50	0.34
	0.40	0.48	1.75	0.45
	0.50	0.57	2.00	0.57
	0.60	0.67	2.25	0.69
	0.70	0.77	2.50	0.79
	0.80	0.85	2.75	0.87
	0.90	0.92	3.00	0.93

Table 2.2-2. (continued)

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability
Adult (continued)	1.00	0.97	3.25	0.97
	1.10	1.00	3.50	1.00
	1.20	1.00	3.75	1.00
	1.30	0.98	4.00	0.99
	1.40	0.94	15.50	0.87
	1.50	0.88	15.75	0.87
	1.60	0.81	16.00	0.85
	1.70	0.74	16.25	0.82
	1.80	0.65	16.50	0.77
	1.90	0.57	16.75	0.70
	2.00	0.49	17.00	0.61
	2.10	0.41	17.25	0.51
	2.20	0.34	17.50	0.41
	2.30	0.28	17.75	0.31
	2.40	0.23	18.00	0.22
	2.50	0.18	18.25	0.14
	2.60	0.14	18.50	0.09
	2.70	0.11	18.75	0.05
	2.80	0.09	19.00	0.02
2.90	0.07	19.50	0.00	
	2.91	0.00	--	--

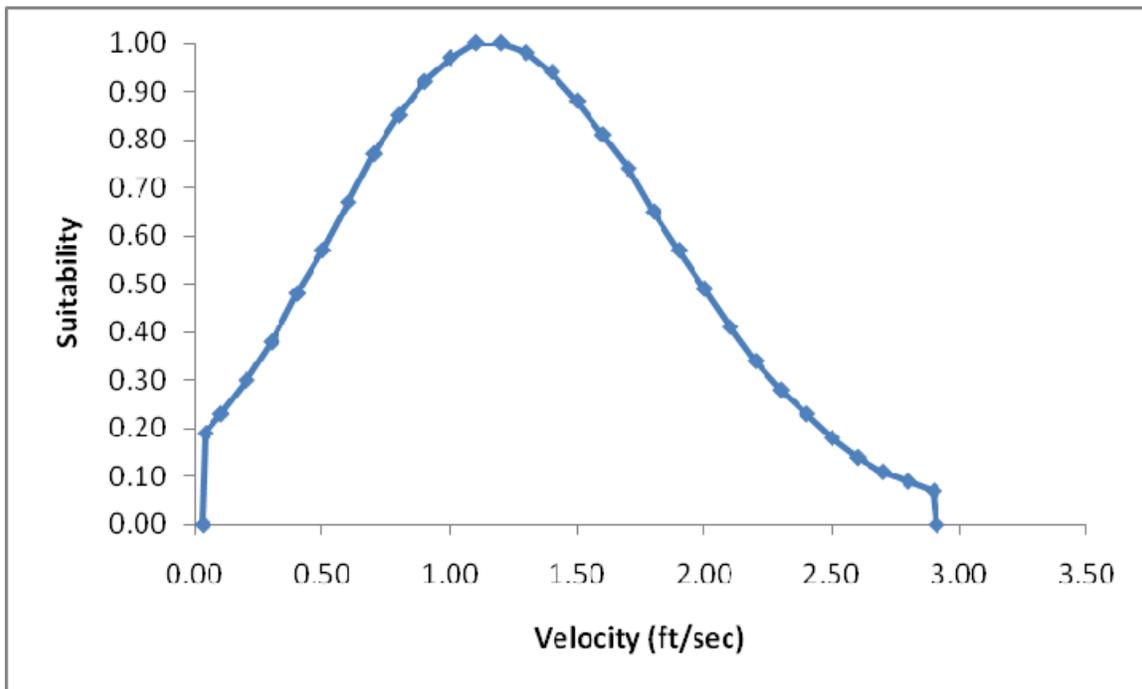


Figure 2.2-1. Rainbow trout adult velocity HSC. USFWS 2004.

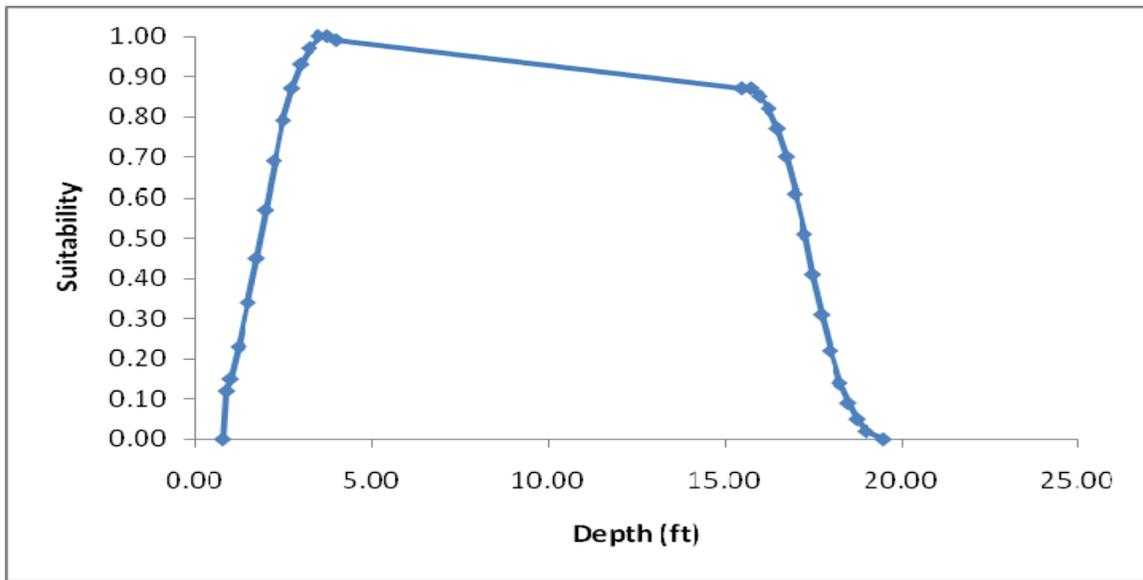


Figure 2.2-2. Rainbow trout adult velocity HSC. USFWS 2004.

Table 2.2-3. Rainbow trout juvenile HSC. USFWS 2004.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability
Juvenile	0.10	0.77	0.50	0.19
	0.20	0.83	0.75	0.33
	0.30	0.88	1.00	0.50
	0.40	0.92	1.25	0.67
	0.50	0.96	1.50	0.82
	0.60	0.98	1.75	0.92
	0.70	1.00	2.00	0.98
	0.80	1.00	2.25	1.00
	0.90	0.99	2.50	0.98
	1.00	0.98	2.75	0.93
	1.10	0.96	3.00	0.86
	1.20	0.92	3.25	0.78
	1.30	0.89	3.50	0.70
	1.40	0.84	3.75	0.62
	1.50	0.79	4.00	0.54
	1.60	0.74	4.25	0.47
	1.70	0.68	4.50	0.41
	1.80	0.63	4.75	0.36
	1.90	0.57	8.75	0.34
	2.00	0.51	9.00	0.34
2.10	0.46	9.25	0.33	
2.20	0.41	9.40	0.31	
2.30	0.36	9.50	0.00	
2.40	0.31	--	--	
2.50	0.27	--	--	
2.60	0.24	--	--	
2.70	0.20	--	--	
2.80	0.17	--	--	
2.85	0.16	--	--	
2.86	0.00	--	--	

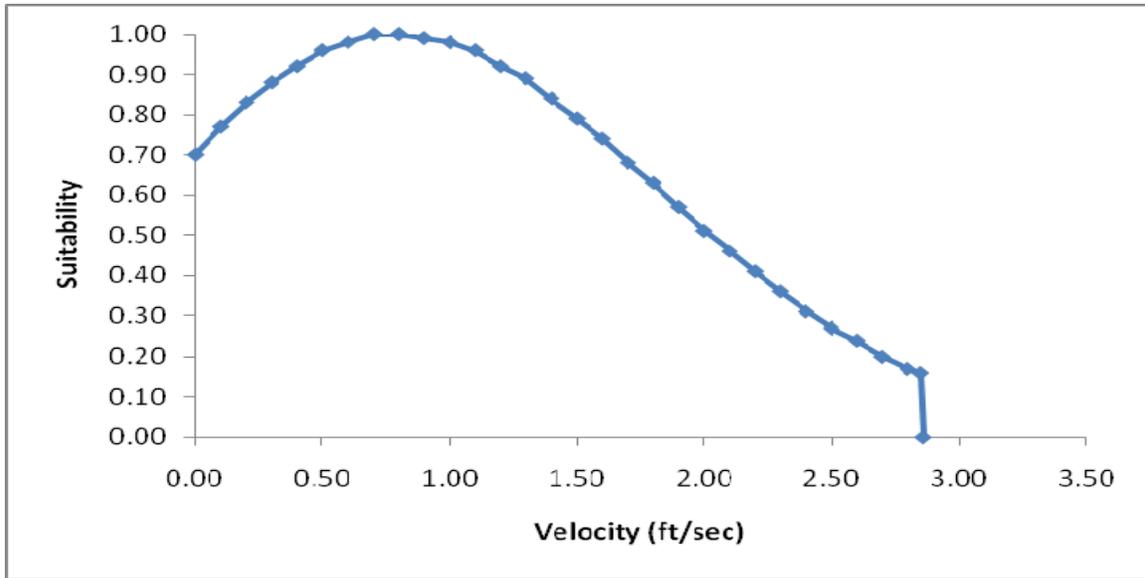


Figure 2.2-3. Rainbow trout juvenile velocity HSC. USFWS 2004.

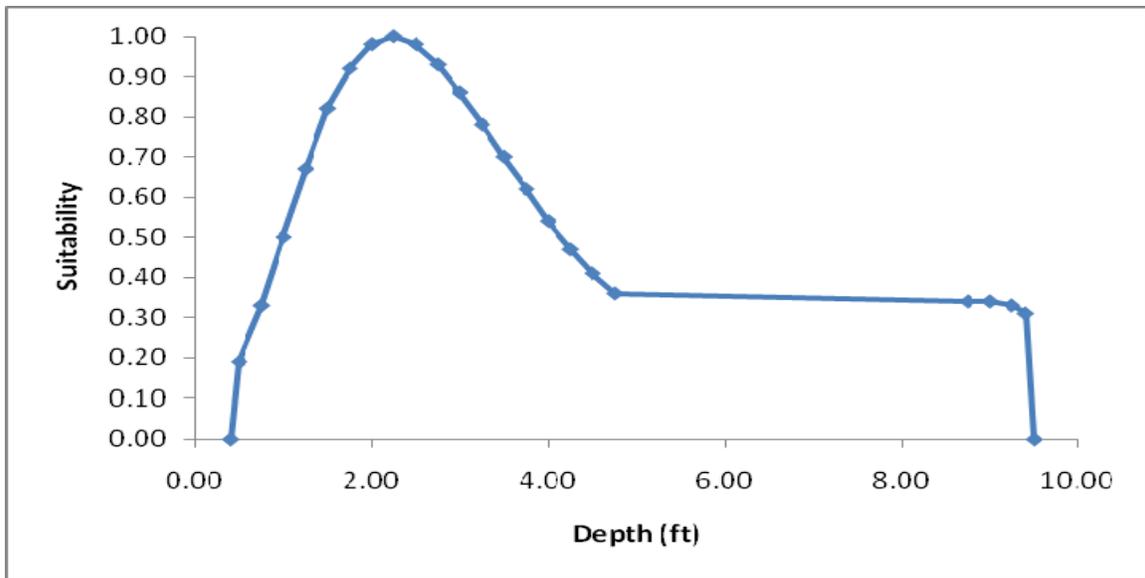


Figure 2.2-4. Rainbow trout juvenile depth HSC. USFWS 2004.

Table 2.2-4. Rainbow trout juvenile HSC. USFWS 2008.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability	Cover Code	Suitability
Fry	0.00	1.00	0.10	0.00	0.00	0.00
	0.10	1.00	0.20	0.47	0.10	0.12
	0.20	0.99	0.40	0.57	1.00	0.57
	0.30	0.98	0.50	0.63	2.00	0.28
	0.40	0.97	0.60	0.67	3.00	0.28
	0.50	0.96	0.70	0.72	3.70	1.00
	0.60	0.94	0.80	0.77	4.00	0.57
	0.70	0.92	1.00	0.85	4.70	1.00

Table 2.2-4. (continued)

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability	Cover Code	Suitability
Fry (continued)	0.80	0.89	1.10	0.88	5.00	1.00
	0.90	0.87	1.20	0.91	5.70	1.00
	1.00	0.84	1.30	0.94	7.00	0.28
	1.10	0.81	1.50	0.98	8.00	1.00
	1.20	0.78	1.70	1.00	9.00	0.12
	1.30	0.74	1.90	1.00	9.70	0.12
	1.40	0.71	2.20	0.97	10.00	1.00
	1.50	0.67	2.40	0.93	11.00	0.00
	1.60	0.63	2.50	0.90	--	--
	1.70	0.60	2.90	0.78	--	--
	1.80	0.56	3.00	0.75	--	--
	1.90	0.52	3.10	0.71	--	--
	2.00	0.48	3.20	0.67	--	--
	2.10	0.45	3.30	0.64	--	--
	2.20	0.41	3.40	0.60	--	--
	2.30	0.38	3.50	0.57	--	--
	2.40	0.34	3.60	0.53	--	--
	2.50	0.31	3.70	0.50	--	--
	2.60	0.28	3.80	0.46	--	--
	2.70	0.25	4.20	0.34	--	--
	2.80	0.23	4.30	0.32	--	--
	2.90	0.20	4.40	0.29	--	--
	3.00	0.18	4.50	0.27	--	--
	3.10	0.16	4.60	0.24	--	--
	3.20	0.14	4.80	0.20	--	--
	3.30	0.12	4.90	0.19	--	--
	3.40	0.11	5.00	0.17	--	--
	3.50	0.09	5.10	0.16	--	--
	3.60	0.08	5.20	0.14	--	--
	3.66	0.07	5.90	0.07	--	--
	3.67	0.00	6.00	0.07	--	--
	--	--	6.10	0.06	--	--
--	--	6.20	0.06	--	--	
--	--	6.30	0.05	--	--	
--	--	6.40	0.00	--	--	

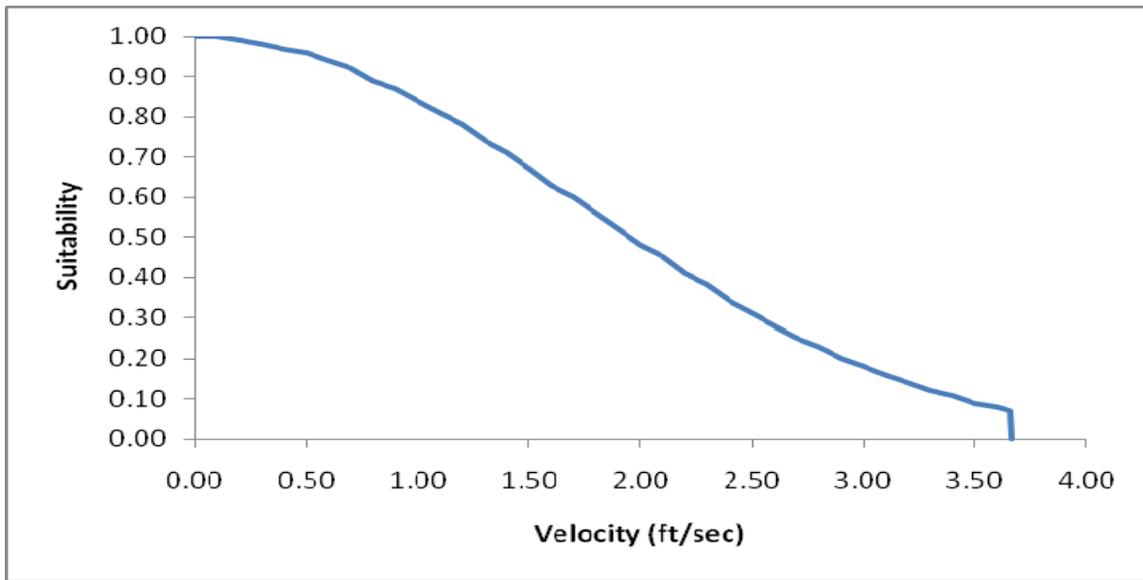


Figure 2.2-5. Rainbow trout fry velocity HSC. USFWS 2008.

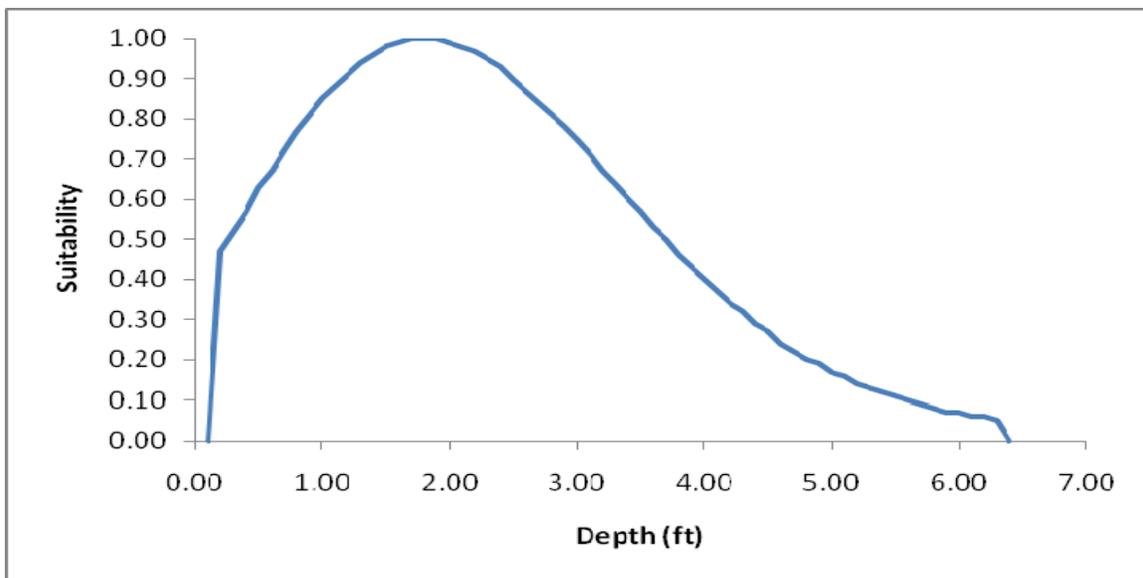


Figure 2.2-6. Rainbow trout fry depth HSC. USFWS 2008.

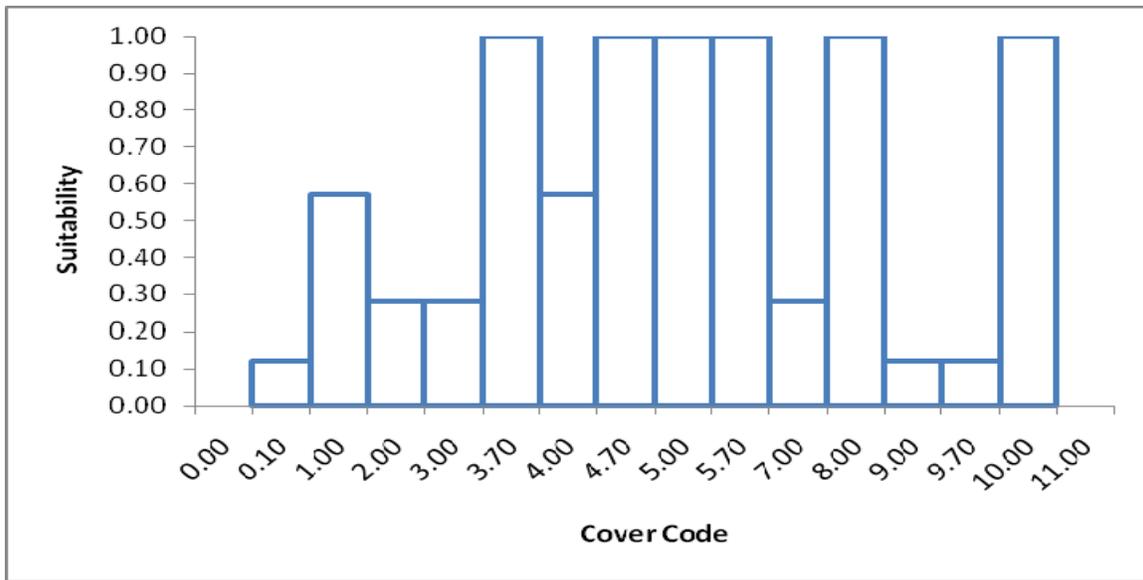


Figure 2.2-7. Rainbow trout fry cover HSC. USFWS 2008.

Table 2.2-5. Rainbow trout spawning HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E) 2010.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability	Substrate Code	Suitability
Spawning	0	0	0.15	0	0	0
	0.6	1	0.6	1	2.3	0
	2	1	1.5	1	2.4	0.25
	4	0	3	0	2.5	0.5
	--	--	--	--	2.6	0.75
	--	--	--	--	2.7	1
	--	--	--	--	5.3	1
	--	--	--	--	5.4	0.5
	--	--	--	--	5.5	0
	--	--	--	--	10	0

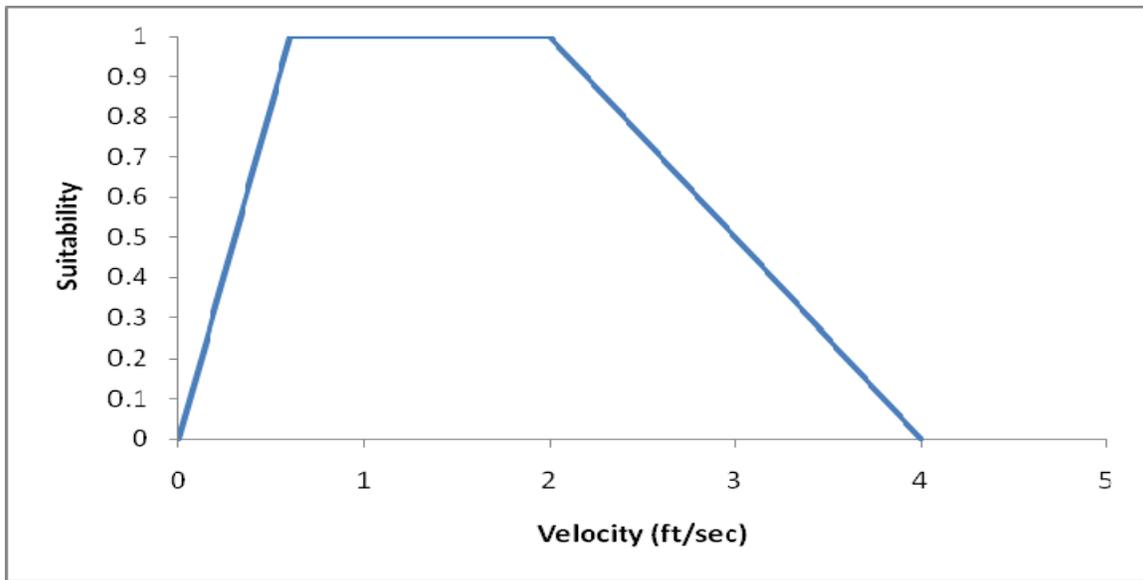


Figure 2.2-8. Rainbow trout spawning velocity HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E). 2010.

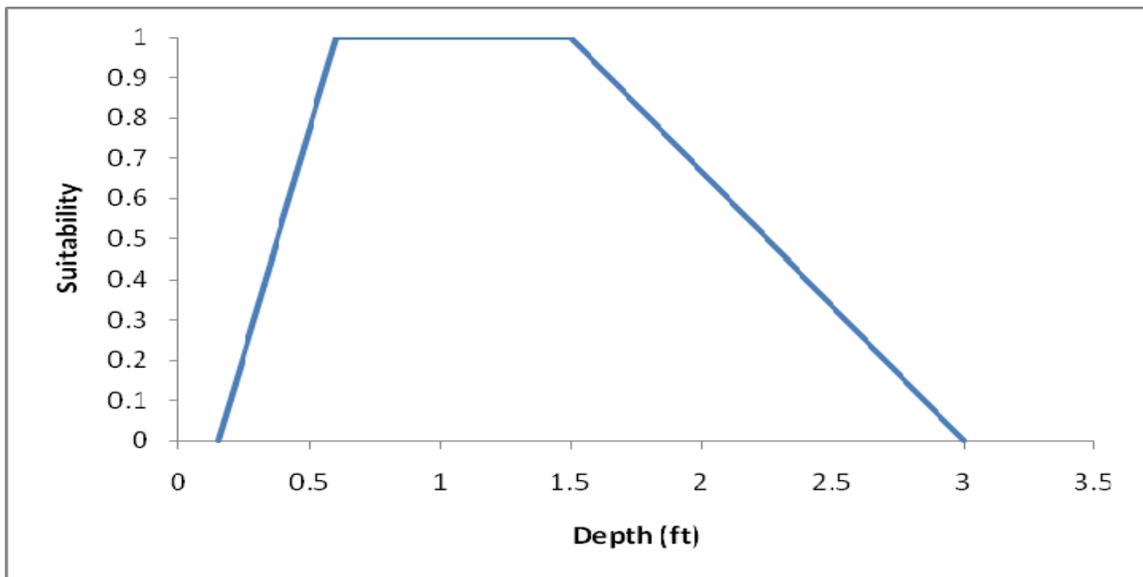


Figure 2.2-9. Rainbow trout spawning depth HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E). 2010.

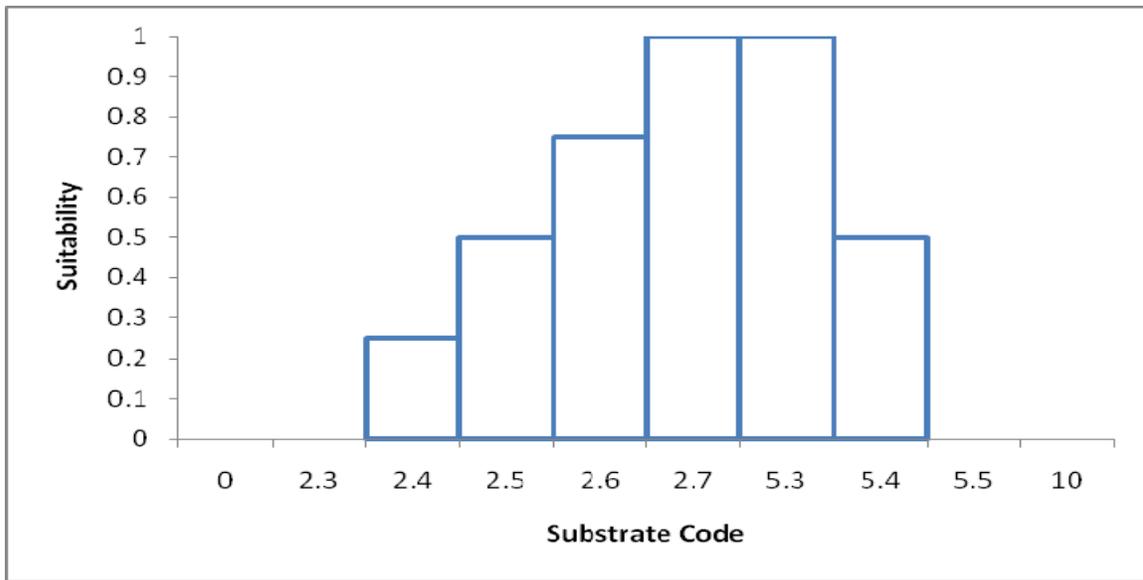


Figure 2.2-10. Rainbow trout spawning substrate HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E). 2010.

Lamprey

Merced ID consulted with Relicensing Participants regarding lamprey Habitat Suitability Criteria (HSC), and on July 29, 2010, filed with FERC collaboratively agreed to Category 1 lamprey HSC for the ammocoete and spawning lifestages.

Table 2.2-6. Lamprey ammocoete HSC.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability	Substrate Code	Suitability
Ammocoete	0	1	0	0	0	0.22
	0.16	0.83	0.01	1	1	1
	0.33	0.38	--	--	2	0.54
	0.66	0.09	--	--	3	0.15
	0.98	0	--	--	5	0.05
	1.31	0	--	--	6	0.06
	1.64	0.04	--	--	7	0.06
	--	--	--	--	8	0.06
	--	--	--	--	9	0.05
	--	--	--	--	10	0.22

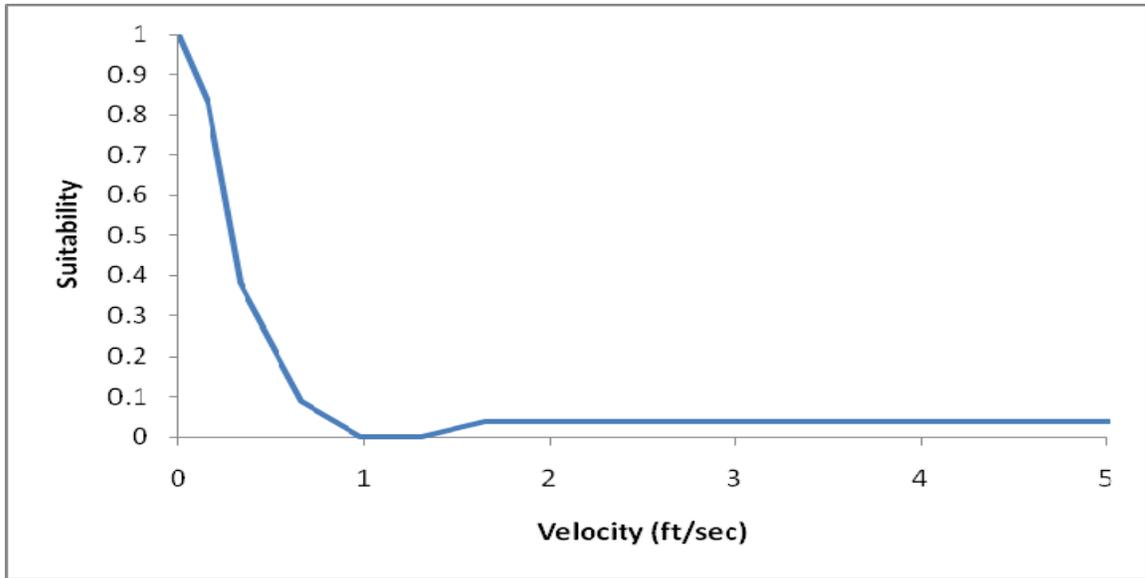


Figure 2.2-11. Lamprey ammocoete velocity HSC.

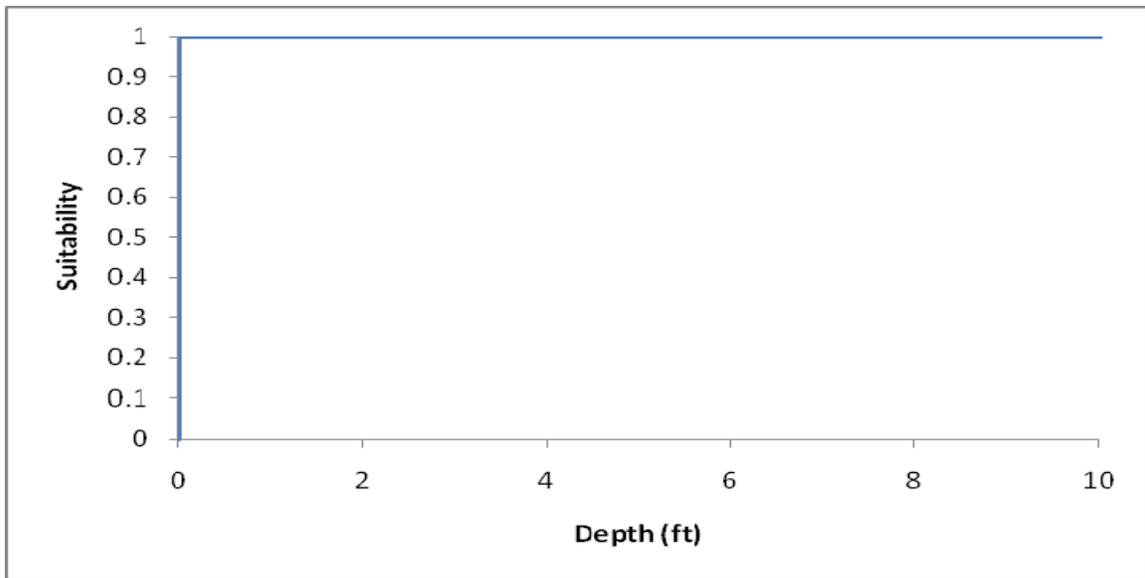


Figure 2.2-12. Lamprey ammocoete depth HSC.

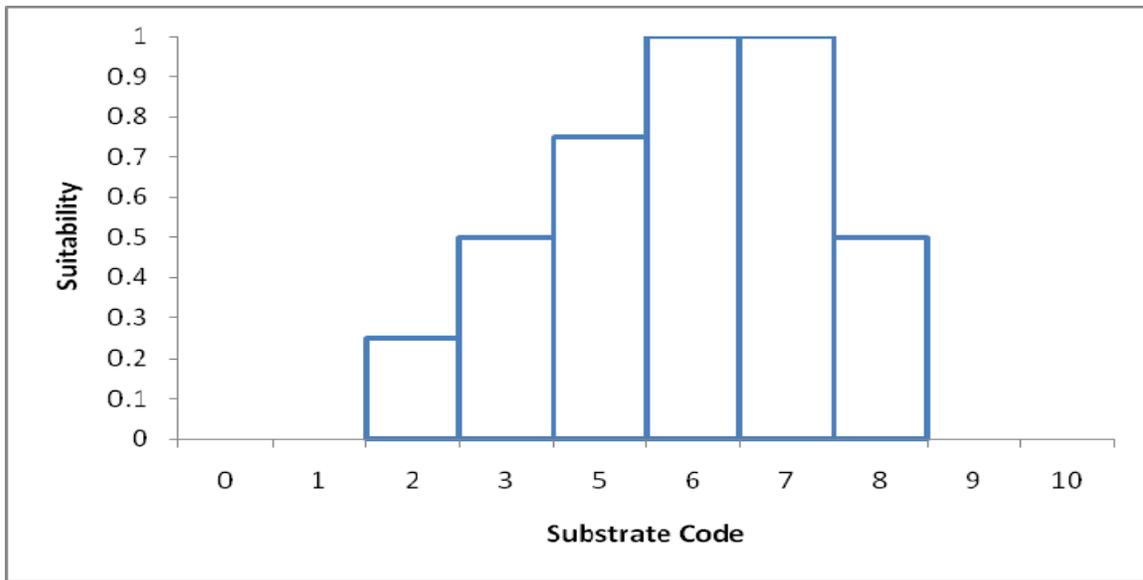


Figure 2.2-13. Lamprey ammocoete depth HSC.

Table 2.2-7. Lamprey spawning HSC.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability	Substrate Code	Suitability
Spawning	0	0	0	0	0	0
	0.66	1	0.52	1	1	0
	3.28	0	4.2	0.1	2	0
	--	--	--	--	3	1
	--	--	--	--	5	1
	--	--	--	--	6	0
	--	--	--	--	8	0
	--	--	--	--	9	0
	--	--	--	--	10	0

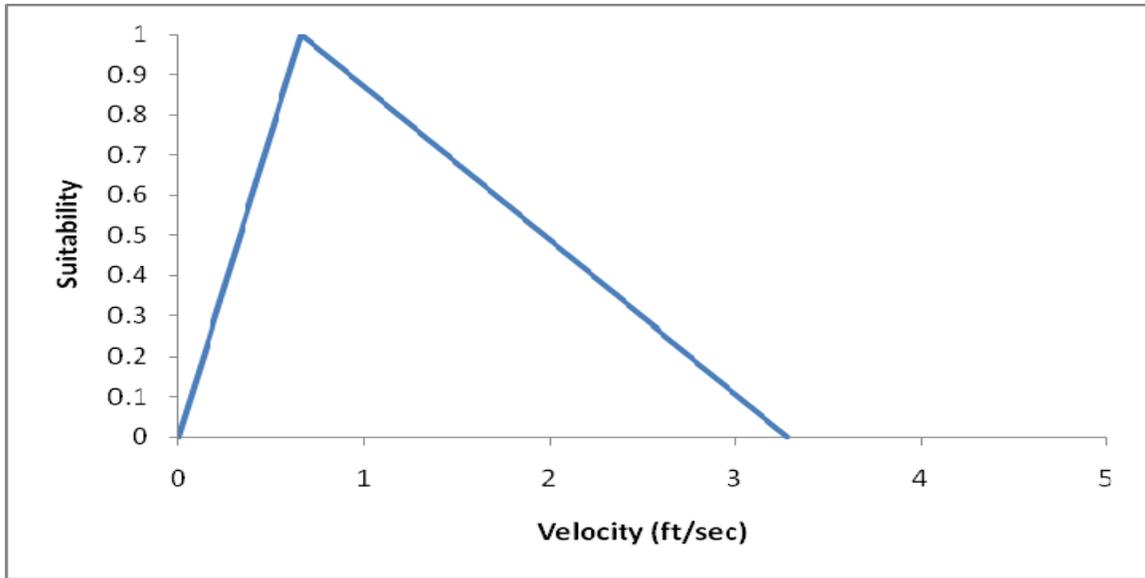


Figure 2.2-14. Lamprey spawning velocity HSC.

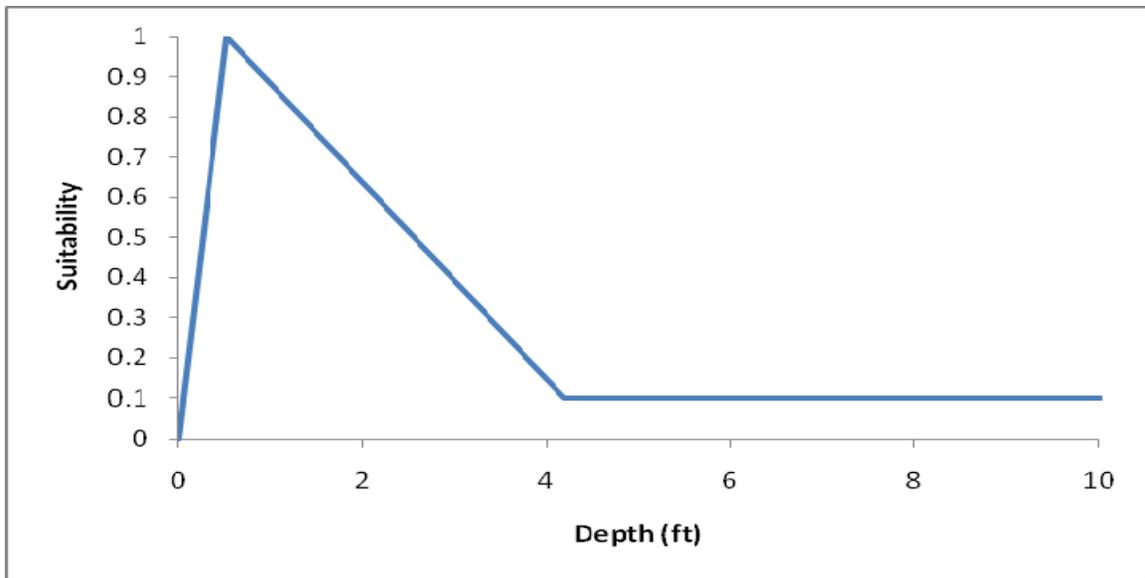


Figure 2.2-15. Lamprey spawning depth HSC.

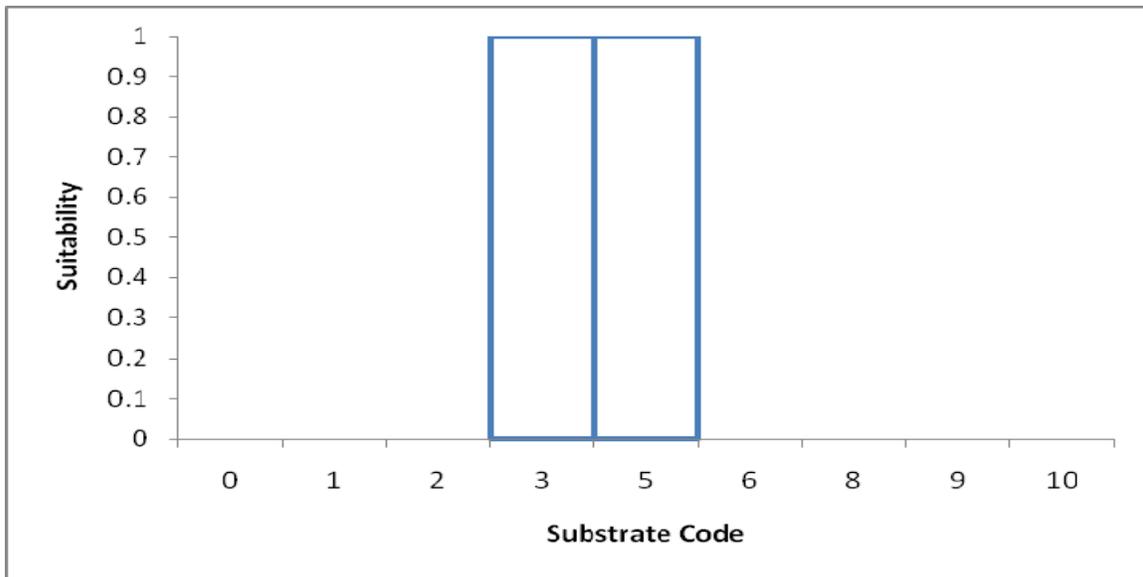


Figure 2.2-16. Lamprey spawning substrate HSC.

Sacramento Sucker

Licensee used HSC that were recently developed for use in NID’s Yuba-Bear Hydroelectric Project (FERC Project No. 2266) and PG&E’s Drum-Spaulding Project (FERC Project No. 2310) for the adult and juvenile life stages. Both of the relicensings are on the Yuba and Bear rivers in California. Note that participants in those relicensings decided that substrate was not an important factor in habitat preference for juvenile and adult sucker, and was not used in those relicensings.

Table 2.2-8. Sacramento sucker adult HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E) 2010.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability
Adult	0.00	1.00	1.99	0.00
	1.50	1.00	2.00	1.00
	1.51	0.00	4.70	1.00
	--	--	4.71	0.00

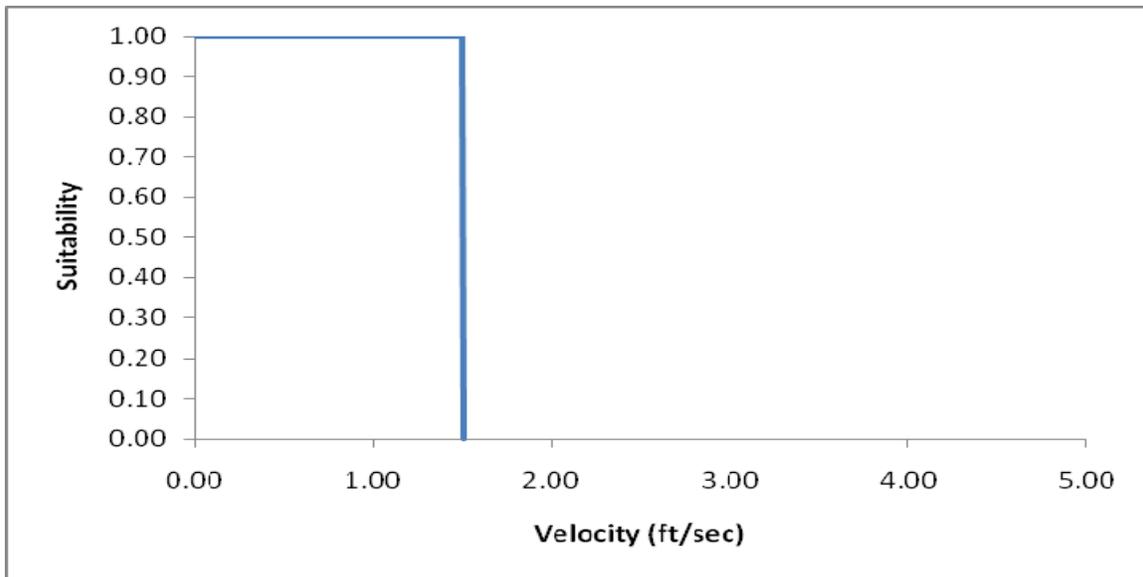


Figure 2.2-17. Sacramento sucker adult velocity HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E) 2010.

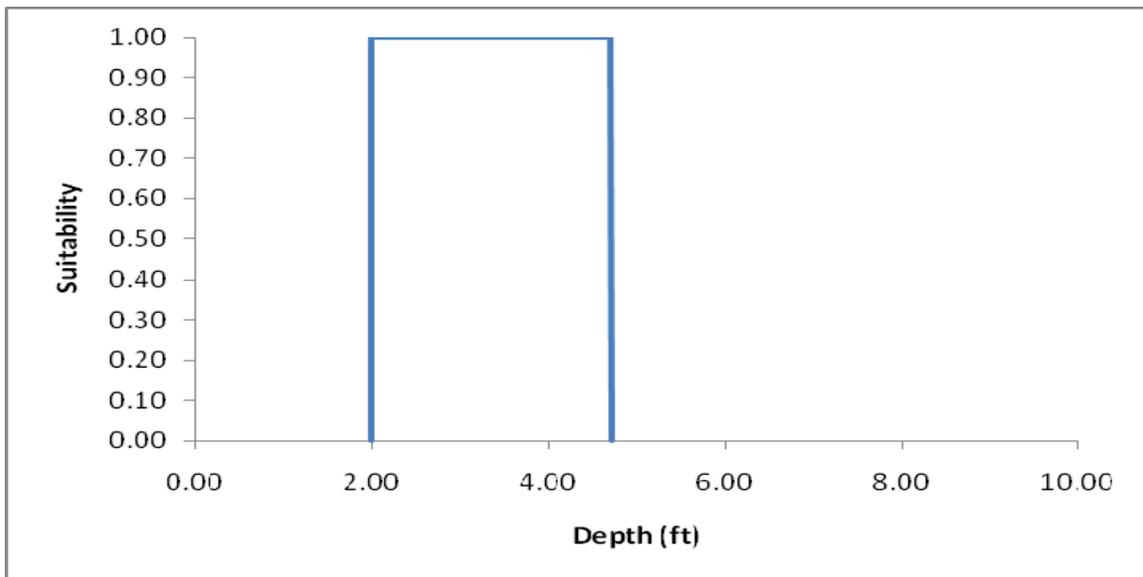


Figure 2.2-18. Sacramento sucker adult depth HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E) 2010.

Table 2.2-9. Sacramento sucker juvenile HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E) 2010.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability
Juvenile	--	--	--	--
	1.20	1.00	0.65	1.00
	1.21	0.00	2.90	1.00
	--	--	2.91	0.00

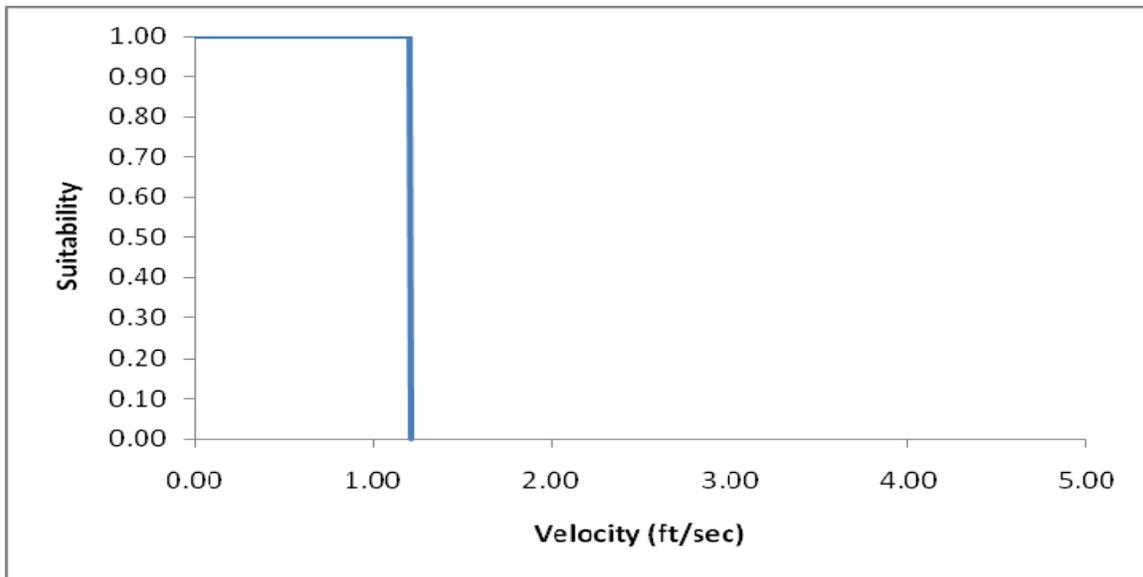


Figure 2.2-19. Sacramento sucker juvenile velocity HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E) 2010.

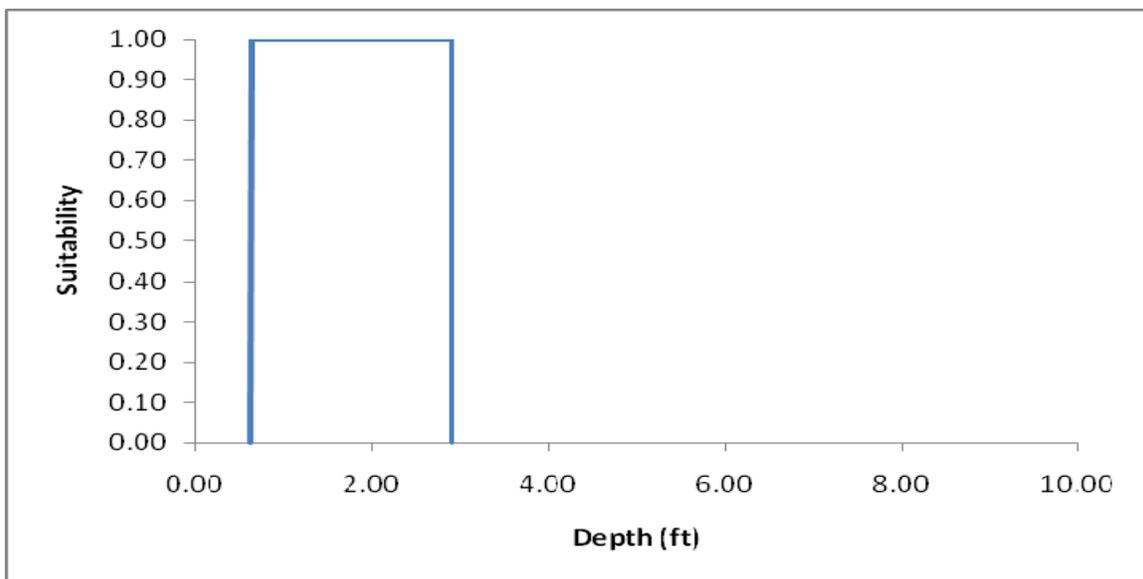


Figure 2.2-20. Sacramento sucker juvenile depth HSC. Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E). 2010.

Sculpin Guild

Licensee used HSC for both adult and juvenile life stages (TRPA 2002) that were developed for use PG&E's Spring Gap-Stanislaus Project (FERC Project No. 2130) relicensing and Tri-Dam Project's (FERC Project No. 2005) relicensing. Both of the relicensings are on the Stanislaus River in California.

Table 2.2-10. Sculpin guild juvenile and adult HSC. TRPA 2002.

Lifestage	Velocity (ft/sec)	Suitability	Depth (ft)	Suitability	Substrate Code	Suitability
Juvenile	0.2	0.58	0.2	0.57	5	0.24
	0.4	0.7	0.4	0.65	6	0.71
	0.6	0.81	0.6	0.73	7	0.64
	0.8	0.89	0.8	0.8	--	--
	1	0.95	1	0.87	--	--
	1.2	0.98	1.2	0.92	--	--
	1.4	1	1.4	0.96	--	--
	1.6	1	1.6	0.98	--	--
	1.8	0.98	1.8	1	--	--
	2	0.96	2	1	--	--
	2.2	0.92	2.2	1	--	--
	2.4	0.88	2.4	0.98	--	--
	2.6	0.83	2.6	0.97	--	--
	2.8	0.78	2.8	0.95	--	--
	3	0.71	3	0.92	--	--
	3.2	0.64	3.2	0.9	--	--
	3.4	0.56	3.4	0.87	--	--
	3.6	0.47	3.6	0.85	--	--
	3.8	0.38	3.8	0.82	--	--
	4	0.29	4	0.8	--	--
4.2	0.21	4.2	0.79	--	--	
4.4	0.14	4.4	0.77	--	--	
4.6	0.09	4.6	0.76	--	--	
4.8	0.05	4.8	0.76	--	--	
5	0.02	8	0.76	--	--	
5.2	0.01	20	0.76	--	--	
5.4	0	--	--	--	--	

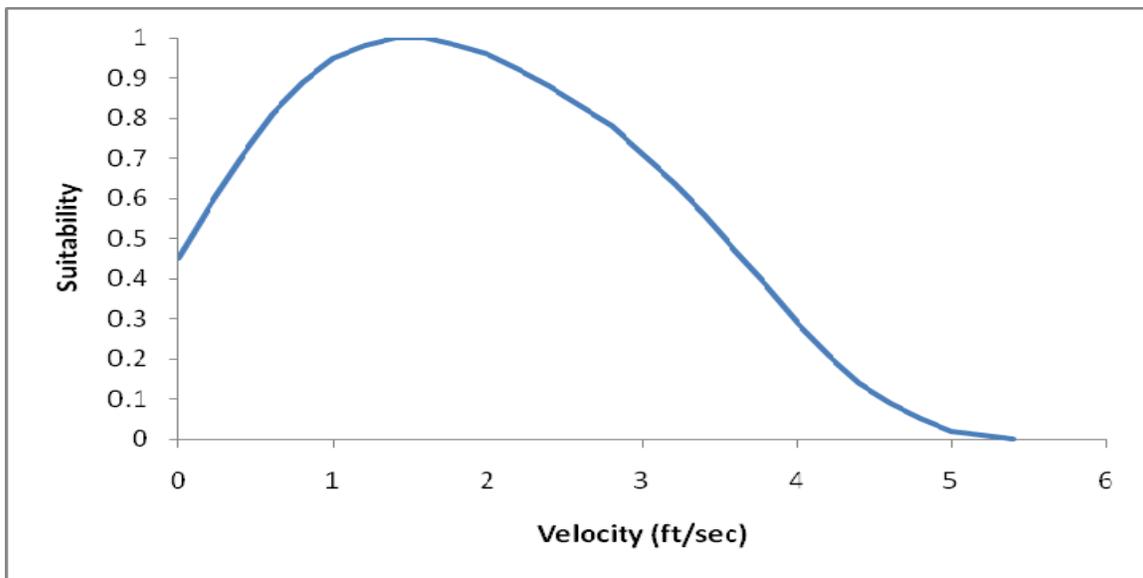


Figure 2.2-21. Sculpin guild juvenile and adult velocity HSC. TRPA 2002.

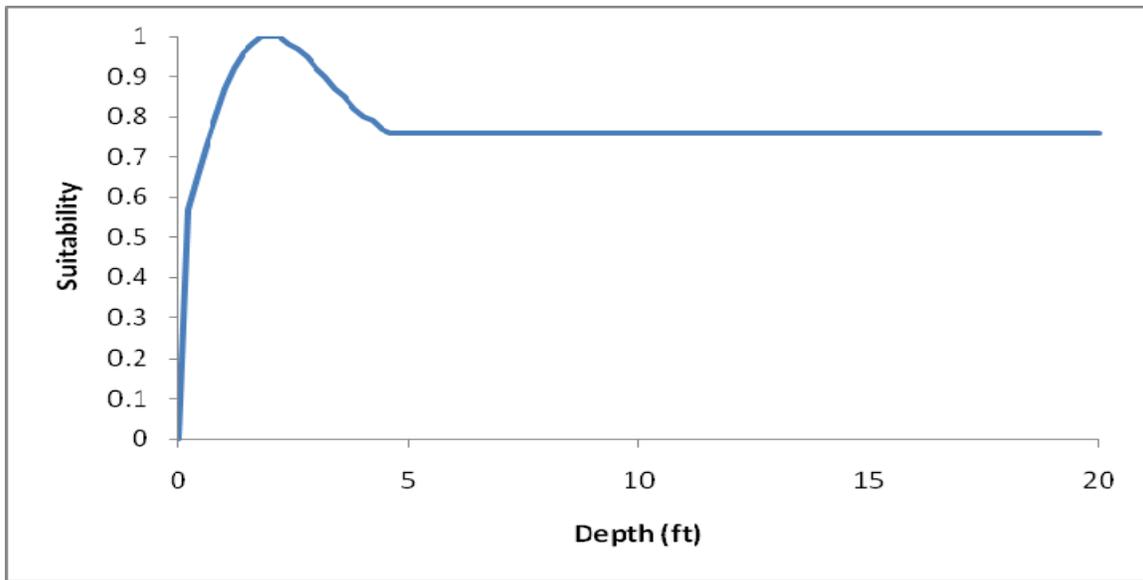


Figure 2.2-22. Sculpin guild juvenile and adult depth HSC. TRPA 2002.

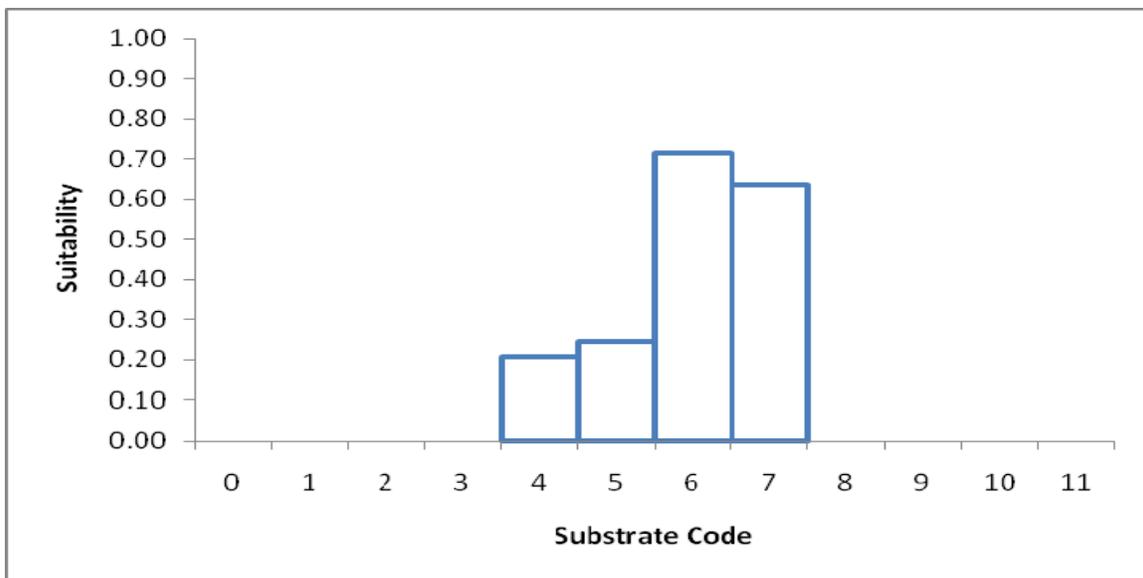


Figure 2.2-23. Sculpin guild juvenile and adult substrate code HSC. TRPA 2002.

2.2.1.2 Species/Lifestage Periodicity

The period of year when a species or lifestage is present in a stream reach is an important component of the HDA model and habitat versus flow decision making. Table 2.2-11 shows the species/lifestage periodicity used for the HDA Merced River below Merced Falls Dam.

The periodicity of each of the target species and lifestages was determined in collaboration with Relicensing Participants. The time periods selected relied primarily on known seasonality in the region, pertinent literature, and professional input from regional biologists.

On the February 16th conference call to discuss the HDA parameters, CDFG staff indicated that observations of mature female rainbow trout spawners had been made below Crocker-Huffman Diversion Dam during the winter months thereby necessitating a need to significantly modify the current periodicity for rainbow trout spawning and rainbow trout fry above Crocker-Huffman Diversion Dam. Merced ID documented the request and asked that CDFG provide documentation to verify the observations. Merced ID indicated that once the documentation was provided they would discuss the findings and their applicability to the study reach below Merced Falls Dam. At the time of submission of this Technical Memorandum, Merced ID had not received the documentation.

Table 2.2-11. Species/lifestage periodicity for Merced River below Merced Falls Dam.

Species	Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lamprey	Ammocoete	X	X	X	X	X	X	X	X	X	X	X	X
	Spawning Adult	--	--	X	X	X	X	--	--	--	--	--	--
	Spawning	--	--	--	X	X	X	--	--	--	--	--	--
Rainbow Trout	Fry	--	--	--	--	--	X	X	X	X	--	--	--
	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X
	Adult	X	X	X	X	X	X	X	X	X	X	X	X
Sacramento Sucker	Juvenile	X	X	X	X	X	X	X	X	X	X	X	X
	Adult	X	X	X	X	X	X	X	X	X	X	X	X
Sculpin	Juvenile and Adult	X	X	X	X	X	X	X	X	X	X	X	X

2.2.2 Step 2 - Target Calibration Flows

Target calibration flows were selected with the goal of achieving relatively even logarithmic spacing of flows and to allow development of an adequate stage/discharge relationship in the PHABSIM models. The stage change between calibration flows was sufficient to test for a linear relationship between the log of discharge and the log of stage minus stage of zero flow.

Selection of target calibration flows was based on reach-specific conditions and developed in consultation with Relicensing Participants. The following guidelines were met in selecting the target calibration flows:

- The calibration flows were within the range of Project flow control.
- Incremental differences between the calibration flows were within the control capabilities of the flow control mechanism.
- The low calibration flow was low enough to model down to the current instream flow requirement and adequately capture low flows that are currently released or expected to be released by the Project.⁴
- The middle calibration flow was the approximate logarithmic midpoint between the high and low calibration flow targets, thus providing the necessary spread to assess the relationship between stage and discharge.
- The high calibration flow was high enough to model up to 10 percent⁵ or greater of the unimpaired flow exceedance curve⁶ or the highest flow anticipated in the reach during the new license, whichever was less.
- The high calibration flow was within the physical limits of field measurement options using manual meters or an acoustic Doppler current profiler (ADCP).

Table 2.2-12 summarizes the target, measured, and gage flows and the date that they were collected.

Table 2.2-12. Target, measured and gage calibration flows for the Merced Falls Dam Reach.

	Target (cfs)	Measured (cfs)	MMF Gage ¹ (cfs)	Date
LOW FLOW (LF)				
Riverine	185	252	280	2/25-26/2010
Impoundment	185	252	280	2/26/2010
MID FLOW (MF)				
Riverine	770	774	785	4/5-6/2010
Impoundment	770	774	785	4/6/2010

⁴ June 1 through October 15 minimum stream flow requirement in Dry Water Years as specified in Article 40 of the current Merced River Hydroelectric Project FERC license is 15 cfs. However, the lowest flows recorded in the last 30 years are about 70-80 cfs.

⁵ To achieve a higher calibration flow range, Merced ID collected a fourth stage/discharge calibration point at 3,309 cfs.

⁶ Percent exceedance flow in the Merced River between PG&E's Merced Falls Dam and non-Project Crocker Huffman Diversion Dam from Water Year 1969 through Water Year 2006.

Table 2.2-12. (continued)

	Target (cfs)	Measured (cfs)	MMF Gage ¹ (cfs)	Date
HIGH FLOW (HF)				
Riverine	2,000	2,112	2,143	07/13-14/2010
Impoundment	2,000	2,064	2,174	7/15/2010
HIGH-HIGH FLOW (HHF)				
Riverine	3,200	3,309	3,208	09/10-11/2010
Impoundment	3,200	3,309	3,225	9/11/2010

¹ Merced River below Merced Falls (MMF) staff gage. Data shown are average daily flows.
 cfs = cubic feet per second

2.2.3 Step 3 – Meso-Habitat Mapping and Study Reach Segmentation

2.2.3.1 Meso-Habitat Mapping

Prior to performing the study, Merced ID mapped stream meso-habitats in the reach at a flow of 277 cfs. Meso-habitat type descriptions used to map the two sub-reaches are listed in Table 2.2-13.

Table 2.2-13. Habitat types identified during habitat mapping if they occurred. (Adapted and modified from McCain et al. 1990, Armantrout 1998, Payne 1992, McMahan et al. 1996, and Hawkins et al. 1993).

FAST WATER	RIFFLES, RAPIDS, SHALLOW STREAM SECTIONS WITH STEEP WATER SURFACE GRADIENT
Turbulent	Channel units having swift current, high channel roughness (large substrate), steep gradient, and non-laminar flow and characterized by surface turbulence.
<i>Riffles</i>	Shallow, lower-gradient channel units with moderate current velocity and some partially exposed substrate (usually cobble). <ul style="list-style-type: none"> • Low gradient — Shallow with swift flowing, turbulent water. Partially exposed substrate dominated by cobble. Gradient moderate (less than 4%). • High gradient — Moderately deep with swift flowing, turbulent water. Partially exposed substrate dominated by boulder. Gradient steep (greater than 4%). Generally not modelable.
Non-Turbulent	Channel units having low channel roughness, moderate gradient, laminar flow, and lack of surface turbulence.
<i>Sheet</i>	Shallow water flowing swiftly over smooth bedrock.
<i>Run</i>	Swiftly flowing (deep) with little surface agitation (run); can appear as flooded riffles.
<i>Step Run</i>	Runs separated by short steps.
<i>Glide</i>	Wide, shallow, smooth flow, little to no surface agitation, usually cobble or smaller substrate.
<i>Pocket Water</i>	Swift flowing water with large boulder or bedrock obstructions creating eddies, small backwater, or scour holes. Gradient low to moderate.
SLOW WATER	POOLS; SLOW, DEEP STREAM SECTIONS WITH NEARLY FLAT WATER SURFACE GRADIENT
<i>Trench</i>	Formed by scouring of bedrock.
<i>Mid-Channel Pool/with and without Emergent Bar</i>	Formed by channel constriction or downstream hydraulic control. Emergent bar may be present.
<i>Lateral Pool with and without Emergent Bar</i>	Formed where flow is deflected by a partial channel obstruction (stream bank, rootwad, log, or boulder), generally in deformable substrate which creates deposition of mobile sediment on the inside of the bend. Emergent bar may be present.
<i>Plunge</i>	Formed by water dropping vertically over channel obstruction.

The meso-habitats in each of the two sub-reaches were mapped by boat, and the beginning and end points of each meso-habitat unit were marked with Global Positioning System (GPS) coordinates. Table 2.2-14 provides the results of the meso-habitat mapping. In total, 14 meso-habitat units were identified. However, the plunge pool below PG&E's Merced Falls Dam was

excluded for purposes of this study because it cannot be modeled, resulting in 13 individual habitat units.

Table 2.2-14. Habitat types in Merced River between PG&E’s Merced Falls Dam and the non-Project Crocker-Huffman Diversion Dam.

Habitat Units	Unit Number	Start (feet)	End (feet)	Length (feet)
HABITAT TYPE BY UNIT				
Merced Falls Dam Tailrace Pool (not mapped as habitat type)	1	0	412	412
Low Gradient Riffle	2	412	451	39
Run	3	451	646	195
Mid-channel Pool	4	646	1,482	836
Low Gradient Riffle	5	1,482	1,894	412
Glide/Flatwater	6	1,894	2,878	984
Low Gradient Riffle	7	2,878	3,225	347
Mid-Channel Pool with Emergent Bar	8	3,225	4,271	1,046
Low Gradient Riffle	9	4,271	4,623	352
Glide/Flatwater	10	4,623	4,944	321
Low Gradient Riffle	11	4,944	5,321	377
Mid-Channel Pool	12	5,321	6,577	1,256
Low Gradient Riffle	13	6,577	7,047	470
Crocker-Huffman Diversion Dam Impoundment (Mid-Channel Pool)	14	7,047	15,840	8,793
HABITAT TYPE SUBTOTALS				
Low Gradient Riffle	6	--	--	1,997
Run	1	--	--	195
Glide/Flatwater	2	--	--	1,305
Mid-Channel Pool	3 (one with emergent bar)	--	--	3,138
Crocker-Huffman Diversion Dam Impoundment (Mid-channel Pool)	1	--	--	8,793
Total	13	--	--	15,428

2.2.3.2 Study Reach Segmentation

The first component of Step 3 was segmentation of the reach into homogeneous stream segments based on geomorphology, hydrology, and channel metrics. A series of very similar reaches having a common channel morphology and flow regime comprise a river segment (Bovee 1982). Segment consolidation, where appropriate, will then reduce the segments into a single study reach or two or more sub-reaches.

Merced ID determined that there was substantial basis for segmentation of the study reach due to the affect of Crocker-Huffman Diversion Dam on river hydraulics in the impoundment pool. There was no basis for further segmentation due to differences in hydrology or channel morphology.

Based on this segmentation, the study reach was split into two sub-reaches. The riverine segment was designated a sub-reach, and extended from the base of Merced Falls Dam below the plunge pool at the base of the dam 1.26 miles downstream to the upper limit of the Crocker-Huffman Diversion Dam impoundment. The impoundment segment was designated a sub-reach, and extended 1.74 miles from the end of the riverine sub-reach to the face of Crocker-Huffman Diversion Dam.

2.2.4 Step 4 - Transect Placement

In PHABSIM modeling, meso-habitat types are sampled approximately in proportion to their abundance in the study reach. Adjustments to the proportional sampling may be made based on the importance or variability of particular meso-habitat types.

Merced ID invited interested and available Relicensing Participants to review instream flow transect locations on February 24, 2010. During the field visit, Relicensing Participants added four transects to the 21 transects proposed by Merced ID, for a total of 25 transects. Table 2.2-15 summarizes the type of and location of selected transects in both the riverine and impoundment sub-reaches.

Table 2.2-15. Transect selection summary and Universal Transverse Mercator (UTM) coordinates.

RIVERINE				
Transect	Habitat	UTM		Comment
1	Low Gradient Riffle	734822	4154603	Incorporates small side channel with Low Gradient Riffle characteristics
2	Low Gradient Riffle	734841	4154628	Riffle crest (pool tail)
3	Pool Belly	734957	4154792	Deep slow
4	Pool Head	735068	4154928	Shallow, run like with fast velocities
5	Low Gradient Riffle	735115	4154979	Mid unit, slight transverse flow, set up perpendicular to flow
6	Glide	735134	4155059	Mid unit, moderate depth
7	Low Gradient Riffle	735171	4155158	Deep on left bank
8	Low Gradient Riffle	735201	4155220	Riffle crest (pool tail) - captures side channel and riffle crest
9	Pool Belly	735313	4155470	Emergent cobble bar on right bank ascending with side channel/backwater
10	Pool Head	735368	4155533	Just downstream of weakly formed Low Gradient Riffle, just upstream of emergent bar
11	Glide	735412	4155626	Shallow
12	Glide	735503	4155727	Deep on left bank
13	Low Gradient Riffle	735634	4155895	Slight transverse flow
14	Low Gradient Riffle	735649	4155927	Riffle crest (pool tail)
15	Pool Tail	735667	4155951	Bedrock on left bank with backwater
16	Pool Belly	735707	4156009	Bedrock on left bank with backwater
17	Pool Belly	735769	4156081	Downstream of left bank bedrock
18	Pool Head	735818	4156113	Fast pool head velocities
19	Run	735977	4156120	Deep, fast
IMPOUNDMENT POOL				
1	Impoundment pool	732688	4154808	Just upstream of Merced ID intake to Main canal
2	Impoundment pool	732960	4154652	Just downstream of right bank ascending cliffs
3	Impoundment pool	733426	4154499	Just downstream of Stoney Creek confluence
4	Impoundment pool	733714	4154592	Upstream of Stoney Creek
5	Impoundment pool	734030	4154627	Just downstream of Birmingham property
6	Impoundment pool	734671	4154594	Velocities apparent at low flow

2.2.5 Step 5 - Field Data Collection

Physical habitat and hydraulic parameters were measured using a combination of standard techniques of the USFWS methodology (Trihey and Wegner 1981, Bovee 1982, Bovee et al. 1998, and Rantz 1982). A description of sampling methods is provided below.

2.2.5.1 Surveying and Controls

All vertical benchmarks, headpins, and tailpins were solidly anchored to prevent movement during the course of the study and for a reasonable time thereafter. All elevations were surveyed by standard differential survey techniques using an auto-level instrument. A level loop was completed once at each transect and pin heights were validated during each visit. Headpin and tailpin elevations, water surface elevations (WSE), hydraulic controls and above-water bed and bank elevations were referenced to a temporary benchmark serving a single transect or transect cluster. All transects were converted into a common datum. Transect locations were fixed, to the accuracy level possible, using a handheld GPS instrument. The distance between each transect (± 0.5 ft) was measured using a laser range finder.

Water surface elevation measurements to the nearest 0.01 foot were completed at each calibration flow. They were measured along both banks and in the middle of each transect. If the center of the stream at a particular transect was too deep to wade, WSEs were measured on both banks.

Wetted streambed elevations were determined by subtracting the measured depth from the surveyed WSE at a measured flow and dry ground elevations were surveyed to the nearest 0.1 foot above the estimated bankfull elevation.

2.2.5.2 Water Surface Elevation-Discharge

Stage/discharge measurements were obtained at four calibration flows which include: low flow (LF) 252 cfs, mid flow (MF) 774 cfs, high flow (HF) 2,112 cfs and high-high flow (HHF) 3,309 cfs. When only a stage/discharge measurement was taken, discharge through the reach was measured at Transect 15 using Swoffer[®] brand velocity meters at LF or at the staff gage site downstream of Merced Falls Dam using an Acoustic Doppler Current Profiler (ADCP) at HHF. All transects where velocities were measured were used in calculating the best estimates of discharge for the MF and HF calibration flows. Target discharge, transect discharge, and data collection methods are shown in Table 2.2-16.

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Table 2.2-16. Summary discharge and measurement method table.

River	Reach	Sub-Reach	Number of Transects	Transect	Type	Discharge											
						Low			Mid			High			High - High		
						Target (cfs)	Measured	Method	Target (cfs)	Measured	Method	Target (cfs)	Measured	Method	Target (cfs)	Measured	Method
Merced River	PG&E's Merced Falls Dam to the non-Project Crocker-Huffman Diversion Dam	Riverine	19	1	Low Gradient Riffle	185	--	--	770	772	Swoffer	2,000	--	--	3,200	--	--
				2	Low Gradient Riffle	185	--	--	770	775	Swoffer	2,000	--	--	3,200	--	--
				3	Pool Belly	185	--	--	770	--	--	2,000	2,048	Swoffer/ADCP	3,200	--	--
				4	Pool Head	185	--	--	770	--	--	2,000	2,205	Swoffer/ADCP	3,200	--	--
				5	Low Gradient Riffle	185	--	--	770	714	Swoffer	2,000	--	--	3,200	--	--
				6	Glide	185	--	--	770	--	--	2,000	2,122	Swoffer/ADCP	3,200	--	--
				7	Low Gradient Riffle	185	--	--	770	791	Swoffer	2,000	--	--	3,200	--	--
				8	Low Gradient Riffle	185	--	--	770	--	--	2,000	2,071	Swoffer/ADCP	3,200	--	--
				9	Pool Belly	185	--	--	770	--	--	2,000	2,046	Swoffer/ADCP	3,200	--	--
				10	Pool Head	185	--	--	770	--	--	2,000	1,991	Swoffer/ADCP	3,200	--	--
				11	Glide	185	--	--	770	--	--	2,000	2,014	Swoffer/ADCP	3,200	--	--
				12	Glide	185	--	--	770	--	--	2,000	2,046	Swoffer/ADCP	3,200	--	--
				13	Low Gradient Riffle	185	254	Swoffer	770	764	Swoffer	2,000	--	--	3,200	--	--
				14	Low Gradient Riffle	185	251	Swoffer	770	781	Swoffer	2,000	--	--	3,200	--	--
				15	Pool Tail	185	--	--	770	--	--	2,000	2,187	Swoffer/ADCP	3,200	--	--
				16	Pool Belly	185	--	--	770	--	--	2,000	2,255	Swoffer/ADCP	3,200	--	--
				Merced Falls Gage		185	--	--	770	--	--	2,000	--	--	3,200	3,309	ADCP
				17	Pool Belly	185	--	--	770	--	--	2,000	2,157	Swoffer/ADCP	3,200	--	--
				18	Pool Head	185	--	--	770	--	--	2,000	2,176	Swoffer/ADCP	3,200	--	--
		19	Run	185	--	--	770	--	--	2,000	2,138	Swoffer/ADCP	3,200	--	--		
		Impoundment	6	1	Impoundment	185	--	--	770	--	--	2,000	2,055	Swoffer/ADCP	3,200	--	--
				2	Impoundment	185	--	--	770	--	--	2,000	2,068	Swoffer/ADCP	3,200	--	--
				3	Impoundment	185	--	--	770	--	--	2,000	2,082	Swoffer/ADCP	3,200	--	--
				4	Impoundment	185	--	--	770	--	--	2,000	2,155	Swoffer/ADCP	3,200	--	--
				5	Impoundment	185	--	--	770	--	--	2,000	1,980	Swoffer/ADCP	3,200	--	--
6	Impoundment			185	--	--	770	--	--	2,000	2,041	Swoffer/ADCP	3,200	--	--		

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2.2.5.3 Calibration Velocity

Velocity measurements were collected at the HF at 13 transects and at the MF at six transects in the riverine sub-reach. Velocity measurements were collected at the HF at all six transects in the impoundment sub-reach. Additional velocity measurements were made in edge/margin habitats on all 25 transects during the HHF release of 3,309 cfs.

Manually collected velocities were measured using calibrated digital Swoffer® brand velocity meters mounted on standard USGS top-set wading rods in depths less than approximately 3.0 feet (ft) or where use of the ADCP was not practical. At cross-sections and flows where depths were predominantly greater than 3.0 ft, velocities were measured using the ADCP mounted on an inflatable cataraft.

When ADCP was used, a minimum of three passes were made at each transect. Table 2.2-16 identifies transects where ADCP was used during data collection. In-field quality control measures including: 'distance made good vs. expected distance', 'discharge vs. expected discharge', 'ship-track perpendicularity', and 'number of lost ensembles' were evaluated after each pass. The goal was to complete at least two 'good' passes. Generally, to reduce potential velocity errors (e.g., decrease standard deviation) and increase time-averaging, data collection modes that average multiple sub-pings per ensemble were selected and boat/ADCP speed was kept lower than or equal to the water speed.

Post-processing of ADCP data for purposes of the PHABSIM modeling required that: 1) velocities in each ADCP data ensemble were reported as a mean column value; 2) mean column velocities were interpolated or averaged to user defined stations across the transect; 3) mean column velocities at each station from 'good' passes were averaged together; and, 4) discharge was calculated using averaged data.

To ensure adequate characterization of microhabitat for all lifestages (e.g., adult, fry, juvenile, and spawning) during manual velocity measurements, sample sites (verticals) along each transect was purposefully placed to describe points where changes in substrate, bed elevation, and velocity occurred. The number of verticals was adjusted in the field to accomplish microhabitat stratification as dictated by site-specific conditions. The placement and number of verticals was also designed to limit discharge in any one cell to no more than 10 percent of total discharge.

To ensure stable data collection conditions, staff gage readings at the Merced River downstream of Merced Falls Dam staff gage were taken twice a day; once when data collection commenced and once at the end of the data collection period. In addition, temporary staff gages were installed while surveying transects and the stage and time of day were recorded throughout the day to note potential changes in stage during the survey of each transect.

2.2.5.4 Substrate

Percent composition of substrate and existence of cover within a 2 ft radius of each vertical was evaluated at eight shallow riffle and glide transects during low-flow conditions in February 2010. Deep water and turbidity precluded the completion of substrate and cover data collection at 17 of

the 25 transects during the low flow conditions in February, 2010. All remaining substrate data collection was subsequently completed in November 2010. Substrate categories, particle size, and coding are shown in Table 2.2-17 while cover types and coding are shown in Table 2.2-18.

Table 2.2-17. Substrate classification for PHABSIM transects.

Substrate Type	Size (inches)	Code
Organics, vegetation	--	0
Clay, silt (fines)	<0.1	1
Sand (coarse)	0.1-0.2	2
Small gravel	0.2-1.0	3
Medium gravel	1-2	4
Large gravel	2-3	5
Small cobble	3-6	6
Medium cobble	6-9	7
Large cobble	9-12	8
Boulder	>12	9
Bedrock	--	10

Table 2.2-18. Cover classification for PHABSIM transects.

Code	Cover Type
0.1	none
1.0	cobble (3-12")
2.0	boulder
3.0	fine woody vegetation (<1")
4.0	branches
5.0	log (>1' diameter)
7.0	Over hanging vegetation (>2' above substrate)
8.0	under cut bank
9.0	aquatic vegetation
10.0	rip-rap
combos: 4.7 = branches with over hanging vegetation	--

2.2.5.5 Transect Photographs

Photographs were taken at all transects from downstream and other points, as necessary, at each measured flow. To the extent possible, each photograph was taken from the same location at each calibration flow. Transect photos at each calibration flow for PHABSIM studies are provided in Attachment 3-4A through 3-4D.

2.2.6 Step 6 – Hydraulic and Habitat Modeling

2.2.6.1 Models Used

RHABSIM 3.0⁷ (Riverine Habitat Simulation), a commercial version of the PHABSIM computer model (Milhous et al. 1984) and HEC-RAS 4.1 (U.S Army Corps of Engineers) were used to develop hydraulic models while only RHABSIM 3.0 was used to model habitat WUA.

⁷ Thomas R. Payne & Associates, the author and owner of the RHABSIM software, agreed to make the software available at no charge to Relicensing Participants on request.

2.2.6.2 Hydraulic Modeling Methods

2.2.6.2.1 Water Surface Elevations

Hydraulic modeling procedures appropriate to the study site and level of data collection were used for modeling water surface elevations across each cross-section. Data file construction, calibration, and simulation followed standard procedures and guidelines outlined in the PHABSIM Reference Manual Version II, Instream Flow Information Paper No. 26 (Milhous et al. 1989), and Waddle 2001.

Riverine Sub-reach

The riverine sub-reach hydraulic model was developed and calibrated in the hydraulic simulation routine of RHABSIM 3.0. Water surface elevation calibration and stage/discharge rating curves were developed in RHABSIM using log-log regression (IFG4), Manning's formula (MANSQ), and/or a step backwater model. Direct comparison of results allowed selection of the most appropriate and accurate method. In the riverine sub-reach, log-log was chosen if: a) individual transects did not calibrate sufficiently well using MANSQ; b) beta did not meet general guidelines (beta ≤ 0.5); or, c) if predicted stages did not match measured calibration stages. The resulting riverine model included both modeling methods. Step-backwater results were not used.

Impoundment Sub-reach

The impoundment sub-reach hydraulic model was developed and calibrated in HEC-RAS 4.1. The HEC-RAS model used a subcritical flow and a downstream to upstream calculation. Areas measured with near-zero or negative velocities were modeled as ineffective flow areas. Increased Manning's N values of 0.14 were used on the banks of the channel to represent the dense aquatic vegetation at the locations noted in the field.

In the absence of accurate elevation drawings of Crocker-Huffman Diversion Dam and the Main Canal, an extrapolation method was used to extrapolate high water surface elevations. Though the extrapolation was an approximation based on known elevations, the backwater going upstream modeled correctly in HEC-RAS. The extrapolation assumed that the highest flows in the impoundment are observed when the Main Canal is not in operation. This is generally true as winter/spring reservoir drawdown pre-releases and storm runoff flows occur when irrigation deliveries are not needed.

The flow over a sharp-crested weir, such as Crocker-Huffman dam, can be described by the *Francis weir equation* below when velocities are negligible (as should be the case in an impoundment).

$$Q = \frac{2}{3} C_1 b \sqrt{2g} H^{3/2}$$

where:

Q = flow

C_1 = empirical discharge coefficient

b = width of weir (dam) crest

H = head on weir

The equation was evaluated for two observed head and flow values, and C_1 adjusted until the flow was as close as possible to the observed flow over the dam. The equation was then used with the adjusted C_1 value to solve for head at the maximum and minimum flows observed in the last 10 years. These head values were used as water surface elevations to complete a rating curve and downstream boundary condition at T1i. Values between the calibration flows and the extrapolated flows are interpolated by HEC-RAS, for a complete set of water surface elevations at each transect in the impoundment.

Manning's N values in HEC-RAS were modified in the main channel to minimize the error between observed and modeled water surface elevations. For the HEC-RAS model, all modeled water surface elevations were 0.2 ft or less from the measured value.

Once calibrated in HEC-RAS, the impoundment cross section geometry and water surface elevation data, coupled with field collected transect velocity, cover and substrate data were imported into RHABSIM for velocity and habitat modeling.

2.2.6.2.2 Velocities

RHABSIM hydraulic models utilized the "one-velocity set" method, which uses measured velocities across a given transect and estimates a Manning's N value for each cell. Calibration techniques include adjustments to the Manning's N to obtain accurate predictions of measured velocities, as well as reasonable predictions of velocities at simulated flows.

The purpose of velocity calibration is to accurately simulate the measured velocities and water surface elevations at the observed flows while at the same time provide reasonable velocities and water surface elevations at the range of simulated flows. Changes to velocities were kept to a minimum and revised only when specific changes improve model performance.

2.2.6.2.3 Simulation Discharges and Extrapolation

Simulated discharges were chosen to model habitat over the full flow range of interest. Extrapolation beyond the highest measured calibration flow is often necessary to achieve as much of the full range as possible (i.e., 10 percent flow exceedance or greater). Extrapolation beyond the measured calibration stage/discharge pairs collected in the field for the riverine sub-reach was 0.4 times the lowest stage/discharge pair (252 cfs) equaling 100 cfs and 2.4 times the highest stage/discharge pair (3,309 cfs) equaling 8,000 cfs. Extrapolation beyond the measured calibration stage/discharge pairs collected in the field for the impoundment sub-reach was 0.77 times the lowest stage/discharge pair (252 cfs) equaling 194 cfs and 1.76 times the highest stage/discharge pair (3,309 cfs) equaling 5,810 cfs. Model performance, channel shape, and modeling methods all contribute to establishing reasonable extrapolation limits within the hydraulic model. Extrapolation limits for each sub-reach model were determined in collaboration with Relicensing Participants.

PHABSIM and HEC-RAS hydraulic model calibration summaries for each sub-reach model are included as Attachment 3-4E, Part 1 and Part 2.

2.2.6.3 Habitat Modeling Methods

Habitat modeling was completed in the habitat simulation routine of RHABSIM 3.0. Computational parameters were agreed to in collaboration with Relicensing Participants. Habitat modeling in PHABSIM integrates a calibrated hydraulic model for a stream reach with HSC to produce a relative habitat suitability index, also known as WUA, which is a function of discharge (Waddle 2001). The available physical habitat WUA, is defined as the sum of stream surface area within a reach or sub-reach, weighted by multiplying area by habitat suitability variables, most often velocity, depth, and substrate or cover, which range from 0.0 to 1.0 each, normalized to square units (either in feet or meters) per 1,000 linear units. WUA does not translate to actual area of suitable habitat but indicates the relative suitability of the available habitat.

Transect weighting factors are the values used in the habitat models in conjunction with the reach lengths to derive the longitudinal distance represented by cells at each cross-section (Waddle 2001). Transect weighting for both sub-reaches is shown below in Table 2.2-19,

Table 2.2-19. Transect weighting table for PHABSIM transects below Merced Falls Dam.

Habitat Type	Number of Transects	Total Length (ft.)	Percent Based on Length (%)	Transect Locations	Transect Weighting (%)
RIVERINE SUB-REACH					
Low Gradient Riffle (LGR)	7	1,766	28.7	T-01, T-02, T-05, T-07, T-08, T-13 & T-14	4.10
Run	1	201	3.27	T-19	3.27
Glide	3	965	15.67	T-06, T11 & T12	5.22
Pool	8	3,223	52.37	T-03, T-04, T-09, T-10, T-15, T-16, T-17 & T-18	6.55
Total	19	6,155	100	19	--
IMPOUNDMENT SUB-REACH					
Pool	6	8,793	100	T-01i, T-02i, T-03i, T-04i, T05i, & T06i	16.67

2.2.7 Step 7 – Habitat Duration Analysis

The WUA function is a static relationship between discharge and habitat and does not represent the actual occurrence of habitat availability. For this reason, WUA is generally not considered the final result of an instream flow study. The next step is a time-series analysis, also referred to as a HDA. An HDA integrates WUA with hydrology to represent the magnitude and duration of available habitat seasonally, under different operational regimes, and water year (WY) types.

Habitat duration curves are particularly useful for assessing the impacts of alternative flow regimes over the complete range of discharges that may be considered as alternative flow scenarios (Waddell 2001, Bovee 1982, Bovee et al. 1998). They are also useful for examining habitat changes due to artificial influences for the time periods identified as critical in the species/lifestage periodicity analysis or on a seasonal basis by simply sampling from the appropriate portions of the time series to build the habitat duration curve (Waddell 2001).

A habitat duration curve is constructed in exactly the same way as a flow duration curve, but uses habitat values instead of discharges as the ordered data. Although habitat duration curves

look like and are based on flow duration curves, there is no direct correspondence between the two. For example, the habitat value that is exceeded 90 percent of the time usually does not correspond to the discharge that has the same exceedance probability. This discordance happens because of the normal bell-shaped data relationship between total habitat and discharge (Bovee et al. 1998). Consequently, some confusion can arise from reading habitat duration curves because a habitat area with a given exceedance probability might be related to more than one discharge (all having different probabilities of exceedance). The habitat duration curve should be used to quantify the differences in habitat between baseline and alternative conditions (Bovee et al. 1998).

The fundamental building block of the habitat duration analysis is the habitat time series. A habitat time series is a chronological ordering of habitat at a selected time-step over a period of record. For the FERC-approved study, HDA mean daily habitat was selected as the time-step. A HDA is the time series converted to an exceedance curve of total habitat. Either of these, habitat time series or habitat duration, is evaluated in different ways depending on the unique aspects of the alternatives analysis. An example of one of many metrics that can be drawn from the HDA is Area Under the Curve (AUC), which is calculated by summing the exceedance values at one percent increments for any portion of the curve (Figure 2.2-24). Figure 2.2-24 shows the entire habitat exceedance curve, however any portion of the exceedance curve can be analyzed. For example, one approach for determining possible WUA bottlenecks when comparing one flow regime to another is to calculate the difference in area under the exceedance curve (AUC) above 90 percent as described by Bovee (1982).

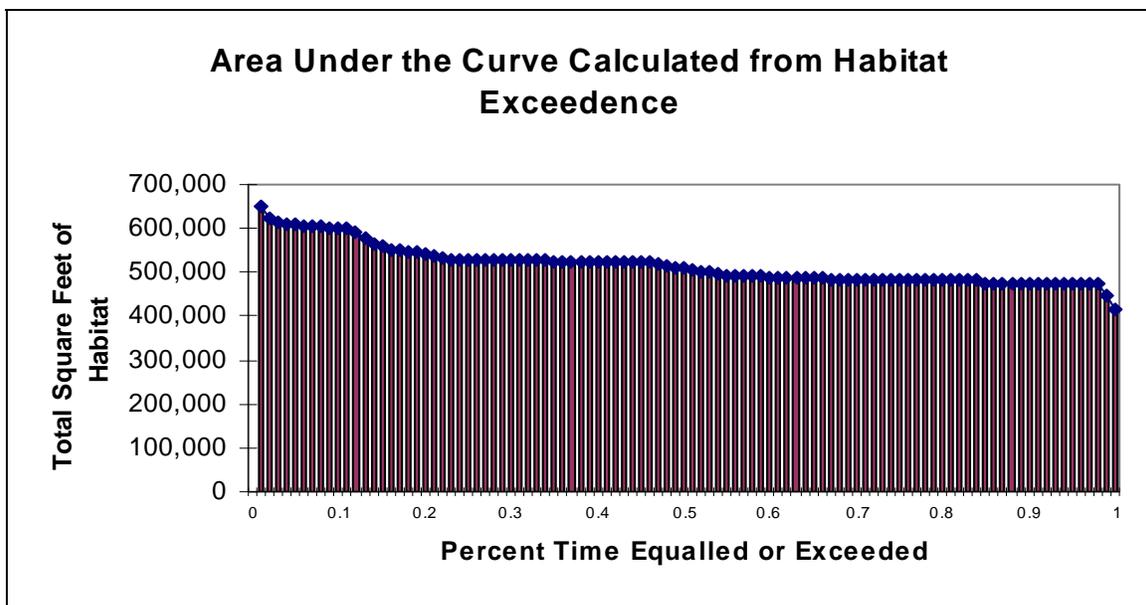


Figure 2.2-24. Example monthly habitat duration curve showing exceedance values at 1 percent increments.

2.2.7.1 WUA Extrapolation

In order to calculate habitat frequency for every day of the full hydrology period of record, the WUA function needs to extend from highest mean daily flow in the record to the lowest (i.e., 0 percent to 100 percent flow exceedance). For the FERC-approved study, HDA extrapolation to 0 and 100 percent exceedance was accomplished in two steps. First, flows were modeled in PHABSIM from 100 to 8,000 cfs. Second, WUA was extrapolated from the lowest modeled flow to 100 percent exceedance (0 cfs) and from the highest modeled flow in PHABSIM to zero percent exceedance (43,887 cfs) for the Unimpaired period of record using a two step approach.

- Downward Extrapolation. All downward extrapolations to zero cfs used a non-linear growth function applied to the first three points of each WUA data set.
- Upward Extrapolation. For the upwards extrapolation, a non-linear exponential extrapolation equation was applied to the last three points of each WUA data set. The non-linear option for extrapolation follows the trend of the regression and never completely bottoms out, which is the most realistic trend line for WUA. However, in some cases, the WUA function rises or is relatively flat over the last three points on the curve. In this instance, the non-linear exponential extrapolation causes an unrealistic growth of available habitat with increasing discharge. If this occurred, increasing or decreasing the number of data points to be used in the extrapolation was evaluated. If this did not produce realistic results, a linear function using the last three points was applied.

2.2.7.2 Habitat Duration Metric

Merced ID computed several metrics from the HDA. All were based on a mean daily habitat for the period of record. Habitat duration was calculated using the program “Multi-flow Habitat Duration” (HDR|DTA 2002).⁸ Input hydrology included unimpaired flows (i.e., the flows that would occur if the Project was not in place and operating) and existing flows for the period of record (Water Years 1969 through 2006).

Merced ID computed the area under each exceedance curve, as well as the mean, the 10 percent, 50 percent, and 90 percent exceedance values for each curve. The whole-series mean is the average value of all habitat events in the series that fall between the 0 and 100 percent exceedance levels. This is the most common and easily understood habitat metric (Bovee et al. 1998).

Merced ID selected the whole-series mean as a metric for the HDA for two reasons: 1) because Merced ID believes in general that, if possible, no part of the hydrologic record should be

⁸ Multi-Flow Habitat Duration is a flexible and fast program that allows the user to input all necessary data and then select which sets or sub-sets of data to use based on project operation specifics and analysis needs. The program has been used in FERC relicensings involving complex projects with multiple points of regulation, 75 years of mean daily hydrologic files, and more than 30 species/life stages, each with different life history periodicities. Multi-flow Habitat Duration will be made available to review agencies, FERC, and NGOs at no cost with the understanding that the Multi-flow Habitat Duration program will not be further distributed for use on other projects or distributed to other consultants.

excluded from the HDA; and, 2) effects of flow modifications would be unknown for the portion of the curve that was excluded.

2.2.7.3 Habitat Duration Analysis Program and Inputs

The large number of calculations in a HDA requires a spreadsheet tool or other numeric computation program. Habitat duration for the Merced River Hydroelectric Project instream flow study was calculated using the program “Multi-flow Habitat Duration” developed by HDR|DTA.

Several inputs are required for the Multi-flow Habitat Duration Program. These are described below:

- Node Locations. A hydrologic node is a specific location (e.g., river mile) where hydrology is calculated for the HDA. The number and location of hydrology nodes were selected in accordance with the FERC-approved study. Two nodes were located in the riverine sub-reach; one node was located immediately below the dam (referred to as “Node 0”) and one node was placed at the average of sub-reach accretion (referred to as “Node 1”). With this node selection, the HDA calculates habitat results for the reach (or uppermost sub-reach) with and without natural accretion.
- Target Species and Lifestages. Target species and lifestages for each reach were selected as presented in Table 2.2-1.
- Periodicity. Lifestage periodicity input to the habitat duration program enabled the program to calculate habitat frequency for only the time of year when the lifestage of interest is present. Periodicity was in accordance with Table 2.2-11.
- Hydrology. Source hydrology, both unimpaired and existing flows was based on the relicensing hydrology database for the period of record ranging from Water Year 1969 through Water Year 2006 (Merced ID 2008). The HDA program was set to calculate habitat frequency for the full period of record (whole-series mean).
- Water Year Type. On February 16, 2010 Relicensing Participants and Merced ID agreed to use the San Joaquin Valley Water Year Hydrologic Classification Index to establish five water year types: Critically Dry, Dry, Below Normal, Above Normal, and Wet.

The Multi-flow Habitat Duration program was configured to calculate habitat duration for two different hydrologic regimes.

- Unimpaired Flow Conditions. The hydrologic regime that would have occurred during the period of record had the dam or diversion not been in place.
- Existing Flow Conditions. The hydrologic regime that would occur under current Project operation during the period of record.

3.0 Results

3.1 PHABSIM and Habitat Duration Analysis

The product of PHABSIM is an index of habitat suitability (also known as WUA), which is a relationship between flow and habitat for each target species/lifestage for each reach or sub-reach. WUA was calculated for both PHABSIM sub-reaches for target species/lifestages specified in the FERC-approved study. The WUA tables and figures below show the relationship between discharge and the availability of suitable habitat for lifestages of target species in terms of square feet per 1,000 linear feet of stream. Refer to Section 2.2.6, PHABSIM Hydraulic Model Calibration and Weighted Usable Area Calculation, for a review of PHABSIM model and modeling methods.

WUA is generally considered a building block of an instream flow analysis. The HDA builds on WUA and is considered an important next step in instream flow analysis after WUA. The value of a habitat duration curve over a WUA function alone is that WUA does not represent the actual occurrence or duration of habitat availability. The product of the HDA is an index of habitat suitability over time for the entire reach or sub-reach.

Tabular WUA data and WUA graphs are provided below for each PHABSIM reach. Included is a WUA curve for spawning, fry, juvenile, and adult rainbow trout as well as a WUA curve for lamprey (ammocoete and spawning), Sacramento sucker (adult and juvenile), and the sculpin guild (adult and juvenile).

A HDA was conducted for the Riverine sub-reach by water year, month, species/lifestage, and hydrologic node for modeled existing flow conditions (Base Case) and synthesized unimpaired flow conditions for the period of record (water years 1969–2006). Refer to Section 2.2.7, Habitat Duration Analysis, for a review of habitat duration methods.

It should be noted that there is little difference in the hydrology data sets between Node 0 and Node 1. In fact, the reach below Merced Falls Dam is a “losing” reach meaning that, at many times of the year, net accretion values are negative. Figures 3.1-1 and Figure 3.1-2 graphically demonstrate the similarity between the existing flow conditions and unimpaired flow conditions at each node. Due to this similarity only data for Node 1 have been provided in this technical memorandum.

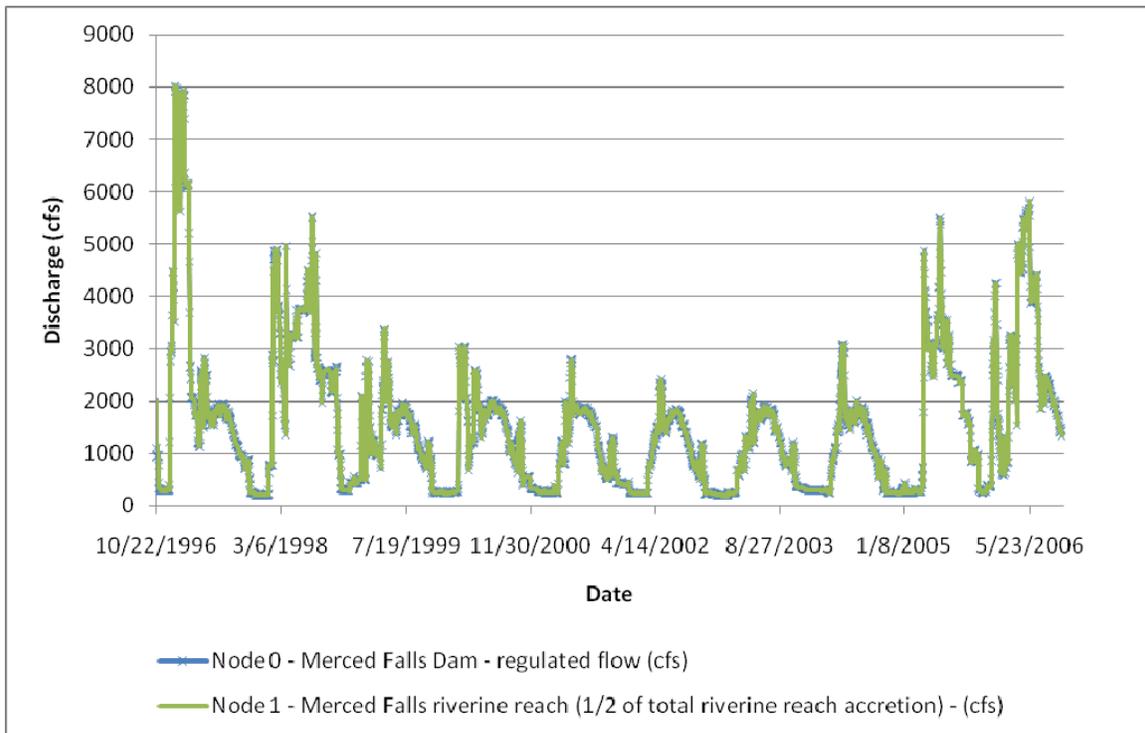


Figure 3.1-1. Existing flow conditions hydrology comparison of Node 0 and Node 1. Last 10 years in dataset shown. In order to see both data sets, Node 0 has point data shown.

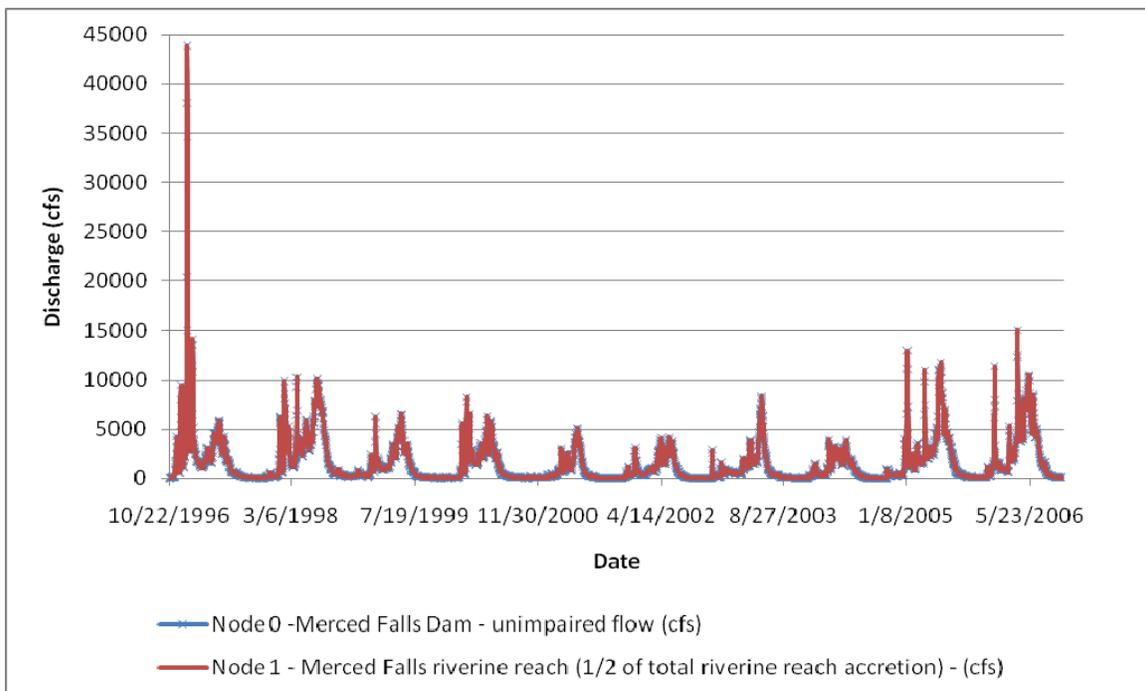


Figure 3.1-2. Unimpaired flow conditions hydrology comparison of Node 0 and Node 1. Last 10 years in dataset shown. In order to see both data sets, Node 0 has point data shown.

An interactive program called the “Habitat Analysis Tool” for the Merced River below Merced Falls Dam is provided in Attachment 3-2F. This program enables users to view WUA, hydrology data, habitat time series and generate habitat duration graphs and tables of any combination of species/lifestage, month, water year type, or hydrology set for the riverine sub-reach of the Merced Falls Dam study reach. Brief instructions on how to start the program and load the individual database for each reach is also provided in the attachment.

3.1.1 Merced Falls – Riverine sub-reach

Habitat index curves (WUA) for the riverine sub-reach are shown in Table 3.1-1 and Table 3.1-2 and in Figure 3.1-3 and Figure 3.1-4. This sub-reach displays a typical suitability curve trend for all life stages in which suitability is lower at very low flows, rises to a peak, and then decreases gradually or flattens out as flows increase. However, unlike typical WUA indexes, habitat continues to increase at very high flows. This second rise or peak in habitat is likely due to a combination of flow overtopping low banks at certain transects, thereby recruiting new habitat, and/or an artifact and limitation of the model in which modeled low velocities along the stream margin are unrealistically propagated as flows increase.

Table 3.1-1. WUA results for all rainbow trout lifestages in the riverine sub-reach.

Discharge (cfs)	Spawning	Fry	Juvenile	Adult
100	6,757	13,397	49,311	20,338
125	7,111	13,760	53,315	24,824
150	7,267	13,932	56,417	28,702
175	7,425	14,016	58,603	32,057
200	7,508	14,070	60,205	34,888
250	7,701	14,023	61,808	39,069
300	8,053	13,820	62,142	41,479
350	8,489	13,537	61,644	42,524
400	8,754	13,212	60,496	42,646
500	8,688	12,495	57,261	41,399
600	8,286	11,963	53,281	39,232
700	7,883	11,491	49,347	36,696
800	7,443	11,066	45,927	34,130
900	6,966	10,737	43,118	31,804
1,000	6,525	10,359	40,797	29,846
1,100	6,105	10,033	39,231	28,014
1,200	5,692	9,769	37,826	26,601
1,300	5,213	9,582	36,567	25,317
1,400	4,763	9,401	35,237	24,254
1,500	4,336	9,219	34,391	23,358
1,750	3,391	8,883	32,680	21,890
2,000	2,621	8,690	31,420	21,121
2,500	1,581	8,527	30,160	20,914
3,000	1,031	8,475	29,066	21,134
3,500	698	8,788	27,633	21,319
4,000	490	9,425	26,933	21,535
5,000	254	10,961	26,925	21,909
6,000	163	12,159	28,380	22,660
7,000	152	13,447	30,454	23,802
8,000	157	14,417	32,884	25,159

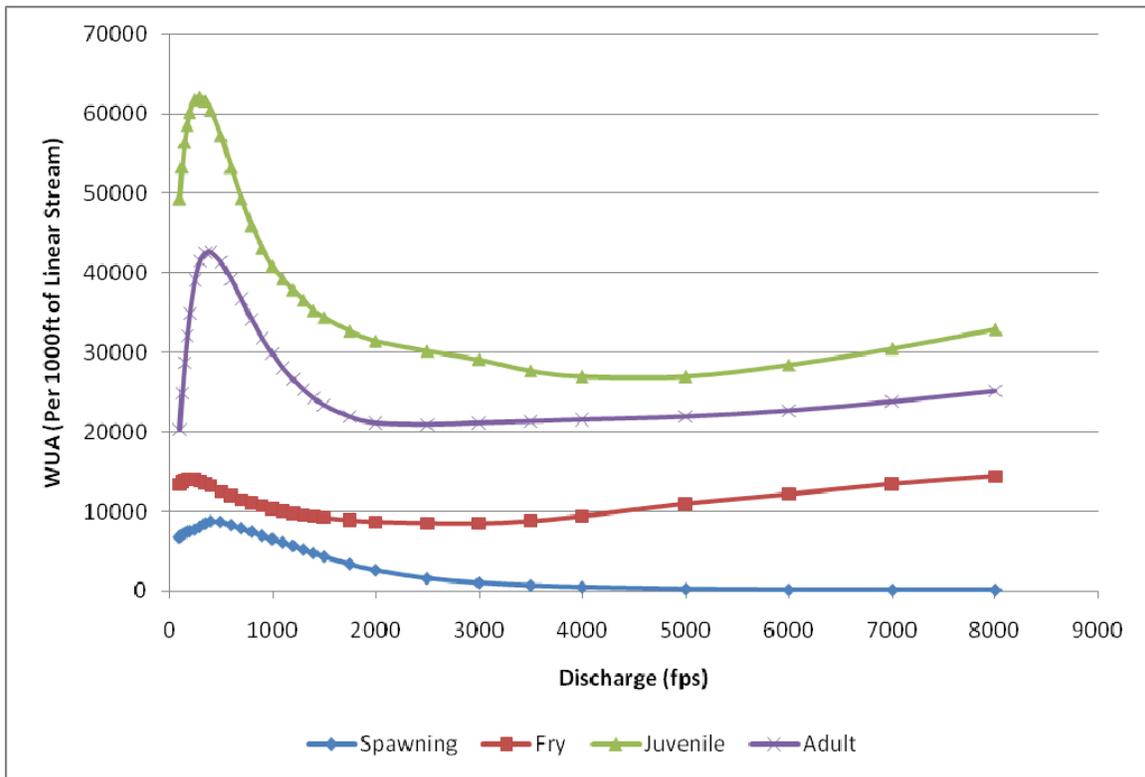


Figure 3.1-3. Modeled habitat suitability index (WUA) for all rainbow trout lifestages in the riverine sub-reach below Merced Falls Dam.

Table 3.1-2. WUA results for lamprey guild, Sacramento sucker and sculpin guild in the riverine sub-reach.

Discharge (cfs)	Lamprey Guild Ammocoete	Lamprey Guild Spawning	Sacramento Sucker Juvenile	Sacramento Sucker Adult	Sculpin Guild Juvenile & Adult
100	23,394	11,039	52,634	23,872	47,986
125	20,707	11,466	54,175	25,453	51,822
150	19,247	11,568	51,902	27,438	54,938
175	17,859	11,559	50,099	30,080	57,589
200	17,067	11,531	48,904	31,071	59,870
250	16,709	11,429	43,220	30,850	63,518
300	15,858	11,409	36,756	28,263	66,041
350	15,180	11,373	33,653	25,504	67,704
400	14,860	11,172	31,098	21,051	68,763
500	15,597	10,354	28,582	16,759	69,790
600	16,333	94,32	25,643	15,235	69,716
700	16,811	8,525	23,581	13,966	68,699
800	17,704	7,685	23,257	13,867	67,158
900	17,481	6,964	22,831	13,702	65,204
1,000	17,149	6,352	22,888	13,293	62,866
1,100	16,784	5,833	23,404	13,587	60,332
1,200	16,339	5,324	24,060	13,334	57,770
1,300	16,077	4,858	25,570	13,732	55,266
1,400	15,903	4,423	26,503	13,797	527,689
1,500	15,696	4,029	26,176	13,529	50,327
1,750	15,506	3,190	25,852	14,046	44,667

Table 3.1-2. (continued)

Discharge (cfs)	Lamprey Guild Ammocoete	Lamprey Guild Spawning	Sacramento Sucker Juvenile	Sacramento Sucker Adult	Sculpin Guild Juvenile & Adult
2,000	15,403	2,583	24,441	15,355	39,593
2,500	14,629	1,875	22,335	18,705	31,237
3,000	14,595	1,517	21,018	21,332	24,899
3,500	14,861	1,275	20,491	22,084	20,585
4,000	16,142	1,052	18,128	21,817	17,860
5,000	16,787	767	20,687	22,055	15,277
6,000	17,373	606	22,915	22,007	14,398
7,000	17,755	536	25,397	21,852	14,232
8,000	17,714	491	27,982	23,610	14,308

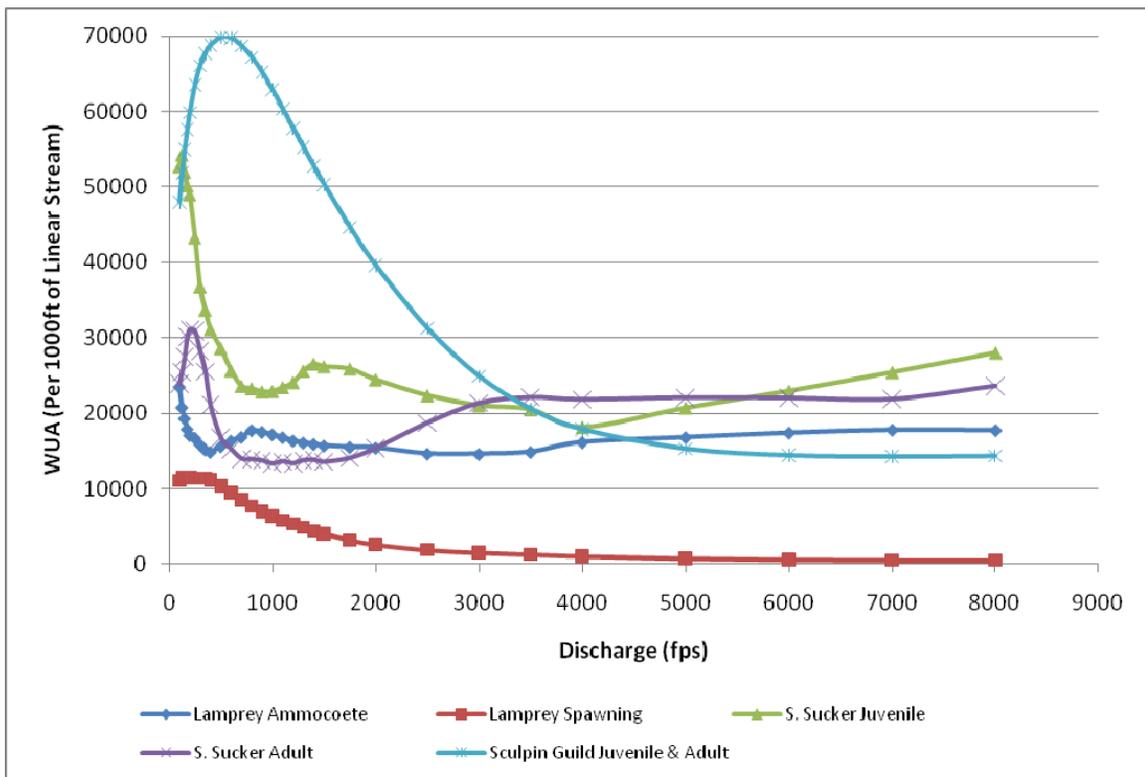


Figure 3.1-4. Modeled habitat suitability index (WUA) for the lamprey guild, Sacramento sucker and sculpin guild in the riverine sub-reach below Merced Falls Dam.

Merced ID computed the area under each species/lifestage exceedance curve, as well as the whole-series mean, the 10 percent, 50 percent, and 90 percent exceedance values for each curve. These metrics are shown below in Tables 3.1-3 to 3.1-14 for existing and unimpaired flow conditions by month and by water year type. The whole-series mean is the average value of all habitat events in the series that fall between the 0 and 100 percent exceedance levels. This is the most common and easily understood habitat metric (Bovee et al. 1998).

Tables 3.1-3 to 3.1-14 are organized as follows:

- Flow Condition (Existing or Unimpaired)
 - Water Year Type (All Water Years, Critically Dry, Dry, Below Normal, Above Normal, Wet)
 - ❖ Month (January – December)

As described above, the whole-series mean, the 10 percent, 50 percent, and 90 percent exceedance values for each curve have been computed and presented for each species/guild and lifestage. The tables do not provide a numerical comparison between total available habitat under existing or unimpaired flow condition, but rather they offer a comparison of total available habitat for each species/guild and lifestage under a particular flow condition in a given water year type, in a given month.

For purposes of this technical memorandum, habitat exceedance charts for each species/lifestage, showing existing and unimpaired flow conditions at Node 1 for “All Water Year Types” (i.e. all water year types combined) for the period of record are provided in Figures 3.1-5 to Figures 3.1-88. A total of 1,040 habitat exceedance charts would be generated if all species/lifestages (9), water year types (5), months (12), nodes (2) were analyzed. As described above, the interactive Habitat Analysis Tool enables users to generate habitat duration graphs and tables of any combination of species/lifestage, month, water year type, or hydrology set for the Riverine sub-reach of the Merced Falls Dam study reach.

In contrast to Tables 3.1-3 to 3.1-14, Figures 3.1-88 present habitat exceedance graphically. In this form, it is possible to visually compare the total available habitat for each species/guild and lifestage for each flow condition. On each chart Merced ID has provided the total AUC calculation for each curve as well a comparison of the total habitat under an unimpaired flow condition to the total habitat under an existing flow condition.

Table 3.1-3. Exceedance Summary Tables – Existing Flow Conditions – All Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,953	516,291	483,807	460,619	46,061,934
Rainbow Trout Adult	359,486	336,323	302,069	290,142	29,014,230
Lamprey Ammocoete	173,817	151,522	144,633	142,733	14,273,287
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	444,005	408,758	346,212	329,878	32,987,823
Sacramento Sucker Juvenile	262,221	258,297	226,205	215,053	21,505,277
Sculpin Guild Juvenile and Adult	586,976	555,509	522,682	490,215	49,021,534

b) February - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,545	514,760	459,364	437,019	43,701,949
Rainbow Trout Adult	355,103	324,475	285,803	275,071	27,507,067
Lamprey Ammocoete	176,218	151,563	145,134	143,079	14,307,873
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	446,405	408,916	336,820	320,576	32,057,627
Sacramento Sucker Juvenile	262,236	259,048	222,502	211,667	21,166,704
Sculpin Guild Juvenile and Adult	585,273	544,581	498,407	463,917	46,391,693

c) March - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,255	486,281	403,131	386,224	38,622,391
Rainbow Trout Adult	348,984	311,553	265,015	256,294	25,629,414
Lamprey Ammocoete	162,473	147,727	141,357	139,597	13,959,736
Lamprey Spawning	97,557	90,950	66,271	60,586	6,058,626
Sacramento Sucker Juvenile	432,007	342,457	277,749	267,301	26,730,142
Sacramento Sucker Juvenile	262,130	230,950	185,134	177,976	17,797,595
Sculpin Guild Juvenile and Adult	587,683	547,238	478,359	446,858	44,685,768

d) April - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	71,147	56,280	40,904	37,119	3,711,876
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	493,207	375,099	326,478	316,798	31,679,760
Rainbow Trout Adult	341,800	264,042	229,445	224,244	22,424,366
Lamprey Ammocoete	150,820	142,430	137,196	135,856	13,585,586
Lamprey Spawning	92,254	60,364	43,405	39,812	3,981,209
Sacramento Sucker Juvenile	316,526	235,204	215,869	210,909	21,090,913
Sacramento Sucker Juvenile	214,081	167,736	144,601	141,456	14,145,561
Sculpin Guild Juvenile and Adult	585,688	522,507	431,237	402,061	40,206,060

e) May - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	63,371	42,706	29,998	27,214	2,721,377
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	409,227	317,900	289,264	283,254	28,325,399
Rainbow Trout Adult	296,999	221,867	203,576	200,946	20,094,609
Lamprey Ammocoete	146,839	138,590	134,108	133,039	13,303,853
Lamprey Spawning	69,626	42,095	30,676	28,247	2,824,657
Sacramento Sucker Juvenile	240,599	219,853	205,653	201,987	20,198,709
Sacramento Sucker Juvenile	193,618	168,330	145,846	142,641	14,264,149
Sculpin Guild Juvenile and Adult	561,907	455,644	368,347	344,451	34,445,052

f) June - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	57,696	3,8111	28,692	26,088	2,608,762
Rainbow Trout Fry	100,616	83,722	79,367	78,630	7,863,008
Rainbow Trout Juvenile	367,764	301,865	282,747	277,399	27,739,868
Rainbow Trout Adult	266,820	209,368	196,401	194,523	19,452,271
Lamprey Ammocoete	146,930	137,170	133,890	132,878	13,287,775
Lamprey Spawning	58,956	36,701	28,519	26,355	2,635,530
Sacramento Sucker Juvenile	225,658	217,434	207,533	203,132	20,313,224
Sacramento Sucker Juvenile	187,186	157,343	140,014	137,392	13,739,213
Sculpin Guild Juvenile and Adult	538,107	430,656	366,029	342,915	34,291,510

g) July - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	96,331	80,362	77,222	76,703	7,670,276
Rainbow Trout Juvenile	335,028	289,284	277,673	274,501	27,450,111
Rainbow Trout Adult	240,213	198,962	189,922	188,642	18,864,208
Lamprey Ammocoete	145,536	134,794	132,250	131,409	13,140,945
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	223,002	216,119	209,294	206,491	20,649,097
Sacramento Sucker Juvenile	181,528	146,953	135,288	133,213	13,321,311
Sculpin Guild Juvenile and Adult	509,745	406,312	366,017	348,171	34,817,145

j) October - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	509,675	462,750	406,464	390,730	39,073,008
Rainbow Trout Adult	347,758	293,505	251,992	242,822	24,282,224
Lamprey Ammocoete	208,515	168,056	154,036	151,120	15,111,963
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	454,531	386,002	303,802	291,640	29,163,974
Sacramento Sucker Juvenile	257,911	211,947	172,299	166,404	16,640,415
Sculpin Guild Juvenile and Adult	588,450	545,719	489,633	464,615	46,461,453

h) August - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	91,405	81,403	78,075	77,486	7,748,557
Rainbow Trout Juvenile	371,477	311,768	292,512	288,779	28,877,869
Rainbow Trout Adult	260,167	214,554	199,607	197,368	19,736,829
Lamprey Ammocoete	148,062	136,825	133,646	132,732	13,273,155
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	246,304	223,933	214,474	211,969	21,196,935
Sacramento Sucker Juvenile	167,350	137,775	128,101	126,662	12,666,215
Sculpin Guild Juvenile and Adult	531,364	455,127	405,269	391,482	39,148,154

k) November - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,145	517,243	504,698	489,187	48,918,714
Rainbow Trout Adult	356,651	338,242	317,505	308,649	30,864,882
Lamprey Ammocoete	155,177	146,837	142,529	141,128	14,112,773
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	427,084	409,859	357,439	341,839	34,183,862
Sacramento Sucker Juvenile	262,264	260,581	234,041	222,379	22,237,869
Sculpin Guild Juvenile and Adult	589,248	563,131	537,332	528,332	52,833,202

i) September - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	112,856	93,866	86,474	85,054	8,505,361
Rainbow Trout Juvenile	438,242	371,405	333,977	325,977	32,597,662
Rainbow Trout Adult	312,676	256,433	225,937	219,629	21,962,909
Lamprey Ammocoete	201,021	155,053	144,942	142,945	14,294,462
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	437,423	258,913	231,494	227,031	22,703,054
Sacramento Sucker Juvenile	199,445	147,378	132,931	130,931	13,093,147
Sculpin Guild Juvenile and Adult	577,851	526,466	463,342	443,161	44,316,085

l) December - Node 1 - All Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,565	514,560	495,726	473,118	47,311,754
Rainbow Trout Adult	359,406	339,855	314,636	302,092	30,209,224
Lamprey Ammocoete	152,431	146,355	140,964	139,420	13,942,003
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	425,087	406,372	341,071	325,969	32,596,850
Sacramento Sucker Juvenile	262,230	259,509	223,227	212,515	21,251,509
Sculpin Guild Juvenile and Adult	589,074	565,449	536,191	515,322	51,532,180

Table 3.1-4. Exceedance Summary Tables – Existing Flow Conditions – Critically Dry Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	519,693	513,151	503,105	495,652	49,565,245
Rainbow Trout Adult	350,924	316,416	294,448	283,529	28,352,889
Lamprey Ammocoete	190,669	161,662	153,501	151,330	15,132,962
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	451,107	430,500	415,111	402,995	40,299,491
Sacramento Sucker Juvenile	262,311	261,119	251,705	244,782	24,478,194
Sculpin Guild Juvenile and Adult	572,700	528,311	508,376	499,226	49,922,572

b) February - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	519,573	513,030	499,461	492,611	49,261,130
Rainbow Trout Adult	326,561	307,235	284,254	274,622	27,462,153
Lamprey Ammocoete	188,857	165,239	155,699	154,300	15,429,968
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	452,572	434,015	420,169	415,628	41,562,839
Sacramento Sucker Juvenile	262,358	261,610	253,223	248,612	24,861,209
Sculpin Guild Juvenile and Adult	534,892	517,002	497,957	490,078	49,007,778

c) March - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	520,291	512,494	478,659	460,954	46,095,415
Rainbow Trout Adult	339,481	311,257	287,049	277,483	27,748,322
Lamprey Ammocoete	182,649	154,598	148,863	147,252	14,725,215
Lamprey Spawning	97,654	97,436	90,832	85,601	8,560,091
Sacramento Sucker Juvenile	447,922	422,260	372,806	355,048	35,504,817
Sacramento Sucker Juvenile	262,411	261,331	228,392	216,978	21,697,831
Sculpin Guild Juvenile and Adult	575,417	532,624	512,118	503,353	50,335,329

d) April - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	73,315	67,242	59,465	56,943	5,694,256
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	515,598	455,233	398,172	386,986	38,698,630
Rainbow Trout Adult	355,996	315,024	277,617	269,252	26,925,247
Lamprey Ammocoete	155,664	146,080	141,331	140,104	14,010,409
Lamprey Spawning	97,480	82,311	66,791	63,307	6,330,677
Sacramento Sucker Juvenile	419,257	270,553	239,567	234,940	23,494,040
Sacramento Sucker Juvenile	246,342	161,333	140,706	137,918	13,791,839
Sculpin Guild Juvenile and Adult	589,236	570,041	533,250	520,982	52,098,150

e) May - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	71,256	59,532	51,355	49,184	4,918,441
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	487,906	383,478	347,321	340,379	3,4037,869
Rainbow Trout Adult	343,838	277,195	246,576	240,569	24,056,864
Lamprey Ammocoete	148,914	143,397	139,198	138,304	13,830,392
Lamprey Spawning	88,545	62,887	51,990	49,575	4,957,501
Sacramento Sucker Juvenile	264,137	227,775	215,376	213,231	21,323,054
Sacramento Sucker Juvenile	172,774	128,457	122,314	121,388	12,138,768
Sculpin Guild Juvenile and Adult	585,644	544,418	502,445	490,533	49,053,328

f) June - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	65,669	54,547	46,691	44,884	4,488,403
Rainbow Trout Fry	96,865	87,570	83,362	82,534	8,253,370
Rainbow Trout Juvenile	413,587	349,903	324,124	319,323	31,932,266
Rainbow Trout Adult	305,348	252,578	228,776	224,412	22,441,180
Lamprey Ammocoete	148,077	142,337	138,226	137,503	13,750,322
Lamprey Spawning	71,066	53,977	45,255	43,426	4,342,607
Sacramento Sucker Juvenile	226,687	220,851	212,217	210,325	21,032,531
Sacramento Sucker Juvenile	125,276	118,543	116,726	116,334	11,633,384
Sculpin Guild Juvenile and Adult	574,691	523,119	479,919	469,619	46,961,896

g) July - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	90,574	84,169	80,804	80,122	80,12,167
Rainbow Trout Juvenile	363,872	327,162	307,916	303,967	30,396,701
Rainbow Trout Adult	268,331	232,674	214,559	211,298	21,129,785
Lamprey Ammocoete	147,524	140,149	136,556	135,778	13,577,782
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	223,434	220,503	213,876	211,641	21,164,121
Sacramento Sucker Juvenile	136,719	121,406	118,640	118,082	11,808,189
Sculpin Guild Juvenile and Adult	549,971	496,858	454,868	443,177	44,317,684

h) August - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	103,052	88,891	845,90	83,708	8,370,809
Rainbow Trout Juvenile	423,415	352,330	328,311	323,457	32,345,712
Rainbow Trout Adult	289,696	246,539	227,639	223,685	22,368,514
Lamprey Ammocoete	158,317	144,835	140,083	139,216	13,921,571
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	310,075	237,446	221,756	218,886	21,888,557
Sacramento Sucker Juvenile	158,862	124,873	120,267	119,549	11,954,874
Sculpin Guild Juvenile and Adult	563,792	516,429	482,278	473,007	47,300,721

i) September - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	115,266	109,545	100,634	98,938	9,893,839
Rainbow Trout Juvenile	461,720	417,691	391,228	384,660	38,466,035
Rainbow Trout Adult	327,423	280,918	241,265	231,824	23,182,370
Lamprey Ammocoete	216,896	190,167	169,518	166,378	16,637,824
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	453,971	391,089	304,579	293,427	29,342,700
Sacramento Sucker Juvenile	214,500	180,646	151,545	147,668	14,766,787
Sculpin Guild Juvenile and Adult	584,407	554,467	502,255	490,111	49,011,111

j) October - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	499,355	443,767	396,968	381,633	38,163,325
Rainbow Trout Adult	341,821	249,403	214,018	206,914	20,691,398
Lamprey Ammocoete	219,657	199,253	172,430	167,820	16,781,994
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	454,948	451,975	357,193	338,916	33,891,552
Sacramento Sucker Juvenile	233,723	207,544	182,985	176,233	17,623,277
Sculpin Guild Juvenile and Adult	585,150	490,898	436,343	414,624	41,462,404

k) November - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	521,629	514,182	506,644	496,293	49,629,287
Rainbow Trout Adult	347,899	322,671	306,526	300,176	30,017,615
Lamprey Ammocoete	151,727	147,299	144,397	143,102	14,310,163
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	424,234	417,082	391,254	374,093	37,409,257
Sacramento Sucker Juvenile	262,195	261,521	251,647	239,997	23,999,674
Sculpin Guild Juvenile and Adult	589,320	541,062	522,466	513,871	51,387,059

l) December - Node 1 – Critically Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	519,327	514,109	508,373	504,242	50,424,194
Rainbow Trout Adult	359,990	330,266	311,292	307,906	30,790,638
Lamprey Ammocoete	149,470	147,173	144,181	142,391	14,239,059
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	421,073	416,453	388,764	372,801	37,280,129
Sacramento Sucker Juvenile	262,007	260,989	250,738	239,184	23,918,359
Sculpin Guild Juvenile and Adult	589,281	549,844	527,740	524,151	52,415,059

Table 3.1-5. Exceedance Summary Tables – Existing Flow Conditions – Dry Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,856	523,172	506,629	490,126	49,012,614
Rainbow Trout Adult	360,068	350,527	332,926	324,509	32,450,853
Lamprey Ammocoete	148,599	143,539	139,275	137,947	13,794,653
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	418,303	365,763	321,314	308,519	30,851,888
Sacramento Sucker Juvenile	261,247	255,380	223,233	212,189	21,218,898
Sculpin Guild Juvenile and Adult	586,658	568,878	553,952	547,536	54,753,641

b) February - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,703	522,622	516,405	507,080	50,707,992
Rainbow Trout Adult	350,888	338,745	321,640	316,617	31,661,733
Lamprey Ammocoete	146,953	144,589	142,108	141,194	14,119,410
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	416,958	402,581	375,271	360,261	36,026,084
Sacramento Sucker Juvenile	262,242	261,345	256,451	244,614	24,461,441
Sculpin Guild Juvenile and Adult	573,439	549,299	533,956	530,448	53,044,760

c) March - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,435	513,263	453,820	437,413	43,741,304
Rainbow Trout Adult	349,297	327,414	302,014	291,523	29,152,320
Lamprey Ammocoete	149,543	147,443	143,521	142,275	14,227,532
Lamprey Spawning	97,595	96,229	81,184	76,410	7,641,016
Sacramento Sucker Juvenile	420,766	364,385	293,856	283,769	28,376,872
Sacramento Sucker Juvenile	261,175	247,151	189,724	182,221	18,222,120
Sculpin Guild Juvenile and Adult	586,413	561,993	542,062	529,879	52,987,940

d) April - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	67,541	55,931	47,644	45,186	4,518,608
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	480,740	368,320	334,622	327,896	32,789,555
Rainbow Trout Adult	318,092	258,764	232,424	227,196	22,719,648
Lamprey Ammocoete	148,564	142,656	138,302	137,329	13,732,882
Lamprey Spawning	89,433	59,096	48,255	45,695	4,569,513
Sacramento Sucker Juvenile	316,788	239,390	222,590	219,643	21,964,284
Sacramento Sucker Juvenile	204,214	135,657	126,279	124,955	12,495,461
Sculpin Guild Juvenile and Adult	575,256	522,945	480,965	466,782	46,678,229

e) May - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	44,291	36,377	30,632	28,648	2,864,765
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	309,434	291,301	280,916	277,774	27,777,399
Rainbow Trout Adult	214,706	198,512	190,529	189,217	18,921,731
Lamprey Ammocoete	136,028	133,150	131,655	130,848	13,084,846
Lamprey Spawning	41,288	33,938	29,050	27,563	2,756,258
Sacramento Sucker Juvenile	223,018	219,710	214,617	211,405	21,140,512
Sacramento Sucker Juvenile	173,231	138,319	128,847	127,446	12,744,632
Sculpin Guild Juvenile and Adult	468,062	422,784	386,826	371,514	37,151,366

f) June - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	35,868	30,725	28,104	27,360	2,736,025
Rainbow Trout Fry	77,680	75,820	75,049	74,863	7,486,255
Rainbow Trout Juvenile	289,484	27,9947	275,450	274,270	27,426,969
Rainbow Trout Adult	196,747	18,8410	185,166	184,464	1,8446,350
Lamprey Ammocoete	132,724	13,1487	131,040	130,839	1,3083,915
Lamprey Spawning	33,403	2,8825	26,652	26,068	2,606,821
Sacramento Sucker Juvenile	220,987	218,762	215,487	214,287	21,428,723
Sacramento Sucker Juvenile	135,080	127,349	123,507	122,751	12,275,105
Sculpin Guild Juvenile and Adult	420,286	389,568	372,940	367,908	36,790,814

g) July - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	76,181	74,991	74,411	74,282	7,428,219
Rainbow Trout Juvenile	281,876	275,408	271,749	270,896	27,089,603
Rainbow Trout Adult	189,902	184,815	182,487	182,045	18,204,506
Lamprey Ammocoete	131,641	130,978	130,616	130,431	13,043,060
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	219,498	216,527	212,877	211,866	21,186,634
Sacramento Sucker Juvenile	135,948	129,975	126,090	125,208	12,520,821
Sculpin Guild Juvenile and Adult	396,529	373,778	359,194	355,253	35,525,314

j) October - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	501,379	434,607	379,180	366,434	36,643,406
Rainbow Trout Adult	352,051	312,294	270,409	261,067	26,106,681
Lamprey Ammocoete	149,053	144,511	138,991	137,453	13,745,266
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	311,713	238,648	219,257	215,839	21,583,912
Sacramento Sucker Juvenile	212,055	154,250	136,918	134,542	13,454,211
Sculpin Guild Juvenile and Adult	589,448	571,379	518,368	491,156	49,115,635

h) August - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	84,417	80,822	78,586	78,101	7,810,089
Rainbow Trout Juvenile	329,529	307,771	295,252	292,480	29,247,974
Rainbow Trout Adult	234,859	213,806	202,459	200,184	20,018,446
Lamprey Ammocoete	141,134	136,155	134,054	133,677	13,367,653
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	223,396	220,984	216,799	215,039	21,503,939
Sacramento Sucker Juvenile	128,085	120,860	118,330	117,848	11,784,771
Sculpin Guild Juvenile and Adult	506,095	463,278	429,852	421,150	42,115,048

k) November - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,271	520,418	487,789	466,383	46,638,335
Rainbow Trout Adult	359,227	343,849	313,196	300,711	30,071,094
Lamprey Ammocoete	147,917	143,841	138,893	137,676	13,767,597
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	418,499	388,306	331,815	317,899	31,789,918
Sacramento Sucker Juvenile	262,334	258,929	224,677	213,595	21,359,490
Sculpin Guild Juvenile and Adult	584,717	560,019	531,665	513,630	51,362,993

i) September - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	101,837	93,580	87,890	86,304	8,630,391
Rainbow Trout Juvenile	455,345	390,329	353,919	343,832	34,383,182
Rainbow Trout Adult	333,807	287,469	255,145	247,371	24,737,122
Lamprey Ammocoete	148,974	145,020	140,793	139,120	13,911,964
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	226,287	211,520	204,528	202,711	20,271,102
Sacramento Sucker Juvenile	164,560	130,832	123,546	122,474	12,247,355
Sculpin Guild Juvenile and Adult	587,962	560,347	515,690	489,574	48,957,402

l) December - Node 1 – Dry Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,271	520,418	487,789	466,383	46,638,335
Rainbow Trout Adult	359,227	343,849	313,196	300,711	30,071,094
Lamprey Ammocoete	147,917	143,841	138,893	137,676	13,767,597
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	418,499	388,306	331,815	317,899	31,789,918
Sacramento Sucker Juvenile	262,334	258,929	224,677	213,595	21,359,490
Sculpin Guild Juvenile and Adult	584,717	560,019	531,665	513,630	51,362,993

Table 3.1-6. Exceedance Summary Tables – Existing Flow Conditions – Below Normal Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,913	512,823	469,371	445,906	44,590,579
Rainbow Trout Adult	359,719	344,804	302,857	290,591	29,059,102
Lamprey Ammocoete	165,447	147,459	140,645	139,145	13,914,508
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	443,041	382,387	315,190	300,507	30,050,732
Sacramento Sucker Juvenile	261,911	244,749	206,755	197,476	19,747,622
Sculpin Guild Juvenile and Adult	589,180	566,730	525,804	490,817	49,081,701

b) February - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,860	467,280	388,012	374,331	37,433,094
Rainbow Trout Adult	355,447	310,940	261,051	252,652	25,265,189
Lamprey Ammocoete	147,316	142,218	136,641	135,325	13,532,527
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	409,796	304,163	257,561	250,241	25,024,089
Sacramento Sucker Juvenile	262,194	207,053	168,856	163,221	16,322,081
Sculpin Guild Juvenile and Adult	587,572	545,237	479,680	456,019	45,601,946

c) March - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	515,039	428,888	368,664	356,712	35,671,248
Rainbow Trout Adult	342,290	290,621	251,639	244,189	24,418,858
Lamprey Ammocoete	146,809	143,263	138,403	136,907	13,690,691
Lamprey Spawning	97,291	75,007	56,739	52,466	5,246,583
Sacramento Sucker Juvenile	406,121	277,354	241,453	235,506	23,550,598
Sacramento Sucker Juvenile	262,214	186,781	154,895	150,687	15,068,660
Sculpin Guild Juvenile and Adult	587,010	540,019	483,493	458,294	45,829,398

d) April - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	68,497	50,551	41,022	38,188	3,818,772
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	457,115	345,672	315,347	309,080	30,908,025
Rainbow Trout Adult	322,578	243,362	218,397	214,270	21,426,954
Lamprey Ammocoete	145,902	138,366	135,033	133,946	13,394,642
Lamprey Spawning	82,043	51,473	40,864	38,318	3,831,842
Sacramento Sucker Juvenile	265,675	228,737	217,034	214,030	21,402,966
Sacramento Sucker Juvenile	186,025	138,479	128,136	126,647	12,664,714
Sculpin Guild Juvenile and Adult	581,498	496,710	444,085	425,079	42,507,920

e) May - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	38,961	32,806	28,560	26,862	2,686,169
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	295,720	283,899	276,569	273,981	27,398,064
Rainbow Trout Adult	202,383	191,989	186,626	185,710	18,571,036
Lamprey Ammocoete	133,677	131,993	131,128	130,403	13,040,349
Lamprey Spawning	36,215	30,718	27,169	25,921	2,592,131
Sacramento Sucker Juvenile	221,913	218,854	214,224	211,240	21,123,966
Sacramento Sucker Juvenile	169,837	137,244	128,887	127,465	12,746,488
Sculpin Guild Juvenile and Adult	438,391	401,757	374,862	361,562	36,156,236

f) June - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	36,493	29,795	26,097	24,919	2,491,893
Rainbow Trout Fry	77,920	75,571	74,572	74,340	7,433,974
Rainbow Trout Juvenile	290,668	278,404	272,308	270,600	27,059,999
Rainbow Trout Adult	197,859	187,407	183,418	182,827	18,282,699
Lamprey Ammocoete	132,921	131,364	130,554	129,994	12,999,350
Lamprey Spawning	33,968	28,075	25,100	24,242	2,424,198
Sacramento Sucker Juvenile	221,325	217,356	211,906	209,744	20,974,447
Sacramento Sucker Juvenile	160,362	138,018	130,300	128,858	12,885,833
Sculpin Guild Juvenile and Adult	423,964	383,537	359,254	350,163	35,016,336

g) July - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	75,193	74,424	73,933	73,841	7,384,093
Rainbow Trout Juvenile	276,816	271,991	268,724	268,088	26,808,835
Rainbow Trout Adult	185,599	182,475	180,678	180,403	18,040,267
Lamprey Ammocoete	131,084	130,668	130,139	129,949	12,994,889
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	218,386	213,652	209,797	208,952	20,895,194
Sacramento Sucker Juvenile	138,183	133,678	129,537	128,458	12,845,784
Sculpin Guild Juvenile and Adult	379,667	360,751	346,379	343,153	34,315,259

j) October - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	510,187	494,327	438,372	422,066	42,206,609
Rainbow Trout Adult	345,113	299,666	276,069	267,240	26,724,042
Lamprey Ammocoete	156,920	151,256	145,932	144,201	14,420,143
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	431,084	399,386	313,423	301,482	30,148,223
Sacramento Sucker Juvenile	260,555	239,501	187,255	179,815	17,981,527
Sculpin Guild Juvenile and Adult	589,153	545,083	517,061	501,370	50,137,024

h) August - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	79,622	77,211	75,964	75,696	7,569,562
Rainbow Trout Juvenile	299,781	287,175	280,392	278,792	27,879,202
Rainbow Trout Adult	206,475	194,737	189,247	188,150	18,815,018
Lamprey Ammocoete	134,560	132,446	131,651	131,432	13,143,193
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	222,676	220,397	217,322	216,049	21,604,864
Sacramento Sucker Juvenile	133,130	125,246	121,500	120,826	12,082,602
Sculpin Guild Juvenile and Adult	448,635	412,535	389,435	383,235	38,323,546

k) November - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	516,803	503,734	477,271	471,401	47,140,122
Rainbow Trout Adult	357,834	339,990	324,400	318,558	31,855,757
Lamprey Ammocoete	153,625	145,346	141,242	139,852	13,985,246
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	426,786	357,468	294,148	284,743	28,474,302
Sacramento Sucker Juvenile	261,993	226,747	182,506	176,107	17,610,741
Sculpin Guild Juvenile and Adult	589,345	585,767	566,612	558,221	55,822,092

i) September - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	90,492	85,625	82,619	81,948	8,194,788
Rainbow Trout Juvenile	364,159	336,234	318,442	314,647	31,464,731
Rainbow Trout Adult	268,515	241,584	224,398	220,830	22,083,035
Lamprey Ammocoete	147,348	142,149	138,471	137,772	13,777,240
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	222,964	219,652	210,883	209,113	2,091,337
Sacramento Sucker Juvenile	117,453	116,298	115,243	115,004	11,500,423
Sculpin Guild Juvenile and Adult	549,335	513,743	479,734	470,958	47,095,817

l) December - Node 1 – Below Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,627	513,651	501,882	495,494	49,549,356
Rainbow Trout Adult	359,978	354,932	336,518	329,271	32,927,133
Lamprey Ammocoete	154,193	143,994	137,996	136,771	13,677,121
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	427,542	369,393	315,804	305,318	30,531,841
Sacramento Sucker Juvenile	261,686	243,042	203,838	195,952	19,595,240
Sculpin Guild Juvenile and Adult	589,499	586,115	563,722	555,467	55,546,660

Table 3.1-7. Exceedance Summary Tables – Existing Flow Conditions – Above Normal Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	515,566	512,497	508,326	496,744	49,674,398
Rainbow Trout Adult	360,132	345,577	322,353	318,953	31,895,318
Lamprey Ammocoete	148,687	145,683	139,690	138,310	13,830,951
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	415,421	411,800	346,951	331,947	33,194,750
Sacramento Sucker Juvenile	262,452	261,698	227,116	216,133	21,613,261
Sculpin Guild Juvenile and Adult	581,424	576,879	546,125	541,672	54,167,235

b) February - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,606	520,516	516,986	505,659	50,565,860
Rainbow Trout Adult	360,210	355,659	342,023	336,246	33,624,579
Lamprey Ammocoete	145,340	142,358	136,563	135,479	13,547,895
Lamprey Spawning					
Sacramento Sucker Juvenile	376,815	369,562	323,913	312,618	31,261,810
Sacramento Sucker Juvenile	261,075	260,171	226,440	216,752	21,675,236
Sculpin Guild Juvenile and Adult	580,567	575,360	556,753	554,019	55,401,920

c) March - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,297	465,713	418,905	409,658	40,965,821
Rainbow Trout Adult	354,741	331,086	301,778	294,829	29,482,930
Lamprey Ammocoete	148,089	145,484	142,618	141,274	14,127,439
Lamprey Spawning	96,430	83,378	71,984	69,523	6,952,332
Sacramento Sucker Juvenile	348,758	248,179	224,618	221,458	22,145,796
Sacramento Sucker Juvenile	252,354	158,965	139,423	136,751	13,675,109
Sculpin Guild Juvenile and Adult	589,042	580,371	561,970	555,716	55,571,602

d) April - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	72,314	63,025	56,442	55,205	5,520,527
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	476,366	398,291	363,730	358,249	35,824,895
Rainbow Trout Adult	344,850	292,512	262,810	257,934	25,793,409
Lamprey Ammocoete	148,343	144,501	141,344	140,484	14,048,428
Lamprey Spawning	85,852	67,026	57,377	55,746	5,574,614
Sacramento Sucker Juvenile	237,914	214,565	207,225	205,830	20,583,001
Sacramento Sucker Juvenile	142,819	122,186	118,483	117,915	11,791,519
Sculpin Guild Juvenile and Adult	587,430	562,157	529,870	523,581	52,358,055

e) May - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	66,859	55,491	45,858	43,481	4,348,125
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	421,349	354,254	323,962	318,118	31,811,783
Rainbow Trout Adult	312,069	256,858	228,846	223,831	22,383,091
Lamprey Ammocoete	147,344	142,361	137,906	137,103	13,710,331
Lamprey Spawning	72,943	55,256	44,751	42,458	4,245,783
Sacramento Sucker Juvenile	221,058	217,473	209,874	208,207	20,820,739
Sacramento Sucker Juvenile	131,627	121,607	118,463	117,902	11,790,165
Sculpin Guild Juvenile and Adult	579,971	528,401	474,790	460,668	46,066,786

f) June - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	54,740	40,638	34,859	33,879	3,387,916
Rainbow Trout Fry	87,336	80,074	77,733	77,375	7,737,454
Rainbow Trout Juvenile	344,889	303,703	290,703	288,654	28,865,374
Rainbow Trout Adult	250,788	210,556	198,764	197,022	19,702,215
Lamprey Ammocoete	144,372	135,747	133,582	133,275	13,327,514
Lamprey Spawning	53,346	38,402	32,965	32,080	3,208,041
Sacramento Sucker Juvenile	221,918	219,166	216,507	214,442	21,444,182
Sacramento Sucker Juvenile	125,007	121,613	119,431	118,862	11,886,219
Sculpin Guild Juvenile and Adult	527,993	447,020	413,027	407,095	40,709,503

g) July - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	75,434	75,044	74,733	74,652	7,465,187
Rainbow Trout Juvenile	278,078	275,943	273,980	273,455	27,345,478
Rainbow Trout Adult	186,642	184,980	183,721	183,392	18,339,243
Lamprey Ammocoete	131,220	131,003	130,834	130,790	13,079,049
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	218,780	217,733	215,763	215,202	21,520,237
Sacramento Sucker Juvenile	126,392	124,086	122,079	121,682	12,168,202
Sculpin Guild Juvenile and Adult	383,963	376,404	368,672	366,578	36,657,754

j) October - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,932	506,373	473,346	462,395	46,239,476
Rainbow Trout Adult	355,352	326,789	304,178	300,548	30,054,827
Lamprey Ammocoete	150,549	149,160	145,667	144,133	14,413,255
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	422,730	399,699	317,113	304,706	30,470,579
Sacramento Sucker Juvenile	259,963	254,482	199,282	190,912	19,091,239
Sculpin Guild Juvenile and Adult	587,832	574,405	545,989	540,172	54,017,170

h) August - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	82,470	80,249	78,897	78,535	7,853,501
Rainbow Trout Juvenile	319,072	303,975	296,449	294,529	29,452,901
Rainbow Trout Adult	224,230	210,214	203,202	201,479	20,147,899
Lamprey Ammocoete	137,957	135,261	133,937	133,657	13,365,688
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	223,640	222,220	220,602	219,040	21,904,044
Sacramento Sucker Juvenile	118,792	116,944	116,235	115,921	11,592,144
Sculpin Guild Juvenile and Adult	487,035	457,130	437,693	432,036	43,203,641

k) November - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,685	522,283	515,998	513,886	51,388,571
Rainbow Trout Adult	333,880	331,208	315,174	310,745	31,074,540
Lamprey Ammocoete	151,846	146,337	143,954	143,577	14,357,688
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	424,394	413,234	391,343	387,976	38,797,564
Sacramento Sucker Juvenile	262,253	261,200	260,216	259,316	25,931,630
Sculpin Guild Juvenile and Adult	540,607	537,831	523,843	520,120	52,011,963

i) September - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	94,183	91,408	88,343	87,558	8,755,818
Rainbow Trout Juvenile	393,593	371,849	353,195	348,433	34,843,304
Rainbow Trout Adult	292,536	274,747	257,246	252,649	25,264,853
Lamprey Ammocoete	149,320	147,593	144,745	143,811	14,381,102
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	218,837	203,480	199,665	199,005	19,900,550
Sacramento Sucker Juvenile	117,307	116,382	115,386	115,143	11,514,332
Sculpin Guild Juvenile and Adult	569,873	554,448	533,135	525,886	52,588,555

l) December - Node 1 – Above Normal Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,090	521,400	515,417	514,206	51,420,614
Rainbow Trout Adult	344,906	330,665	314,494	311,580	31,158,031
Lamprey Ammocoete	146,876	145,268	143,557	142,850	14,285,039
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	417,206	413,162	393,712	387,530	38,752,986
Sacramento Sucker Juvenile	262,340	261,390	260,826	259,304	25,930,430
Sculpin Guild Juvenile and Adult	553,130	537,861	523,509	520,981	52,098,097

Table 3.1-8. Exceedance Summary Tables – Existing Flow Conditions – Wet Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,833	514,137	446,645	425,518	42,551,791
Rainbow Trout Adult	355,277	330,644	285,967	275,374	27,537,358
Lamprey Ammocoete	164,257	149,038	142,850	141,082	14,108,151
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	438,958	389,848	318,034	303,721	30,372,064
Sacramento Sucker Juvenile	262,087	253,606	214,780	204,715	20,471,507
Sculpin Guild Juvenile and Adult	587,895	550,429	486,702	450,540	45,053,985

b) February - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,618	497,604	405,349	387,583	38,758,254
Rainbow Trout Adult	353,090	317,005	267,174	258,278	25,827,750
Lamprey Ammocoete	163,408	148,640	142,498	140,638	14,063,841
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	440,093	358,578	284,362	272,620	27,262,002
Sacramento Sucker Juvenile	262,002	236,481	202,358	193,585	19,358,465
Sculpin Guild Juvenile and Adult	587,621	548,249	437,839	406,557	40,655,735

c) March - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	520,648	407,497	335,683	324,891	32,489,096
Rainbow Trout Adult	350,639	274,733	232,776	227,239	22,723,887
Lamprey Ammocoete	152,548	141,190	135,036	133,888	13,388,784
Lamprey Spawning	96,993	67,190	43,418	39,731	3,973,092
Sacramento Sucker Juvenile	400,155	266,977	229,122	222,958	22,295,833
Sacramento Sucker Juvenile	258,977	202,766	174,464	168,449	16,844,916
Sculpin Guild Juvenile and Adult	589,036	501,189	377,467	352,736	35,273,649

d) April - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	60,061	30,495	19,474	17,699	1,769,928
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	383,042	291,963	267,381	263,410	26,340,984
Rainbow Trout Adult	278,991	207,084	194,699	192,942	19,294,246
Lamprey Ammocoete	146,683	138,838	133,418	132,421	13,242,065
Lamprey Spawning	62,870	31,152	21,852	20,237	2,023,725
Sacramento Sucker Juvenile	223,971	205,007	191,823	188,512	18,851,220
Sacramento Sucker Juvenile	186,243	184,540	164,788	159,742	15,974,229
Sculpin Guild Juvenile and Adult	548,043	375,889	285,167	269,147	26,914,749

e) May - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	32,120	15,865	10,833	9,915	991,461
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	282,747	257,617	247,461	245,463	24,546,275
Rainbow Trout Adult	195,255	186,484	182,881	182,279	18,227,931
Lamprey Ammocoete	145,840	138,082	131,899	131,046	13,104,600
Lamprey Spawning	30,124	17,902	13,964	13,124	1,312,427
Sacramento Sucker Juvenile	219,013	194,132	185,605	183,372	18,337,239
Sacramento Sucker Juvenile	186,284	185,257	177,452	171,692	17,169,241
Sculpin Guild Juvenile and Adult	397,550	274,168	222,459	212,630	21,263,025

f) June - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	30,305	20,207	13,533	12,327	1,232,703
Rainbow Trout Fry	109,295	86,429	80,399	79,533	79,533,348
Rainbow Trout Juvenile	279,951	265,138	252,686	250,168	25,016,787
Rainbow Trout Adult	200,613	186,781	183,039	182,473	18,247,298
Lamprey Ammocoete	147,855	137,449	132,760	131,824	13,182,405
Lamprey Spawning	28,545	20,759	15,855	14,773	1,477,298
Sacramento Sucker Juvenile	222,771	205,952	192,046	188,493	18,849,281
Sacramento Sucker Juvenile	189,090	185,289	167,995	163,252	16,325,229
Sculpin Guild Juvenile and Adult	386,485	314,389	248,150	235,575	23,557,474

g) July - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	108,079	81,017	77,277	76,731	7,673,056
Rainbow Trout Juvenile	274,203	266,133	261,694	258,940	25,894,046
Rainbow Trout Adult	199,068	183,565	180,934	180,523	18,052,252
Lamprey Ammocoete	146,958	133,570	130,278	129,594	12,959,432
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	221,969	208,307	201,253	198,204	19,820,398
Sacramento Sucker Juvenile	189,566	166,442	152,503	149,619	14,961,877
Sculpin Guild Juvenile and Adult	363,850	330,376	297,849	280,717	28,071,662

j) October - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	503,324	455,291	399,983	384,437	38,443,685
Rainbow Trout Adult	330,412	280,160	243,859	237,081	23,708,099
Lamprey Ammocoete	195,738	166,665	153,637	150,678	15,067,783
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	455,644	391,156	305,489	292,852	29,285,174
Sacramento Sucker Juvenile	252,577	213,659	172,604	166,677	16,667,697
Sculpin Guild Juvenile and Adult	583,121	536,790	482,554	455,668	45,566,834

h) August - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	77,660	74,675	73,766	73,576	7,357,608
Rainbow Trout Juvenile	289,907	272,874	266,884	265,313	26,531,301
Rainbow Trout Adult	197,207	184,093	181,198	180,769	18,076,912
Lamprey Ammocoete	132,907	130,513	128,693	128,171	12,817,149
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	220,213	211,470	204,764	202,721	20,272,061
Sacramento Sucker Juvenile	167,771	150,592	140,795	138,383	13,838,266
Sculpin Guild Juvenile and Adult	418,829	359,624	330,643	321,870	32,186,966

k) November - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,686	519,891	509,919	500,064	50,006,357
Rainbow Trout Adult	354,663	343,751	321,033	313,595	31,359,541
Lamprey Ammocoete	157,404	147,388	142,633	141,357	14,135,683
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	430,117	409,529	365,639	351,156	35,115,617
Sacramento Sucker Juvenile	262,295	260,292	242,035	230,620	23,062,044
Sculpin Guild Juvenile and Adult	589,070	560,907	536,927	531,366	53,136,633

i) September - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	85,693	79,753	76,747	76,260	76,259,956
Rainbow Trout Juvenile	336,240	301,893	284,090	280,405	28,040,477
Rainbow Trout Adult	241,859	208,689	195,209	193,416	19,341,562
Lamprey Ammocoete	142,320	135,314	131,945	131,100	13,110,040
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	222,483	215,532	207,764	205,007	20,500,700
Sacramento Sucker Juvenile	177,011	148,320	134,100	132,014	13,201,426
Sculpin Guild Juvenile and Adult	514,787	444,475	384,403	368,177	36,817,651

l) December - Node 1 - Wet Water Years - Existing Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,860	513,140	479,933	457,235	45,723,455
Rainbow Trout Adult	358,369	337,506	307,834	295,085	29,508,502
Lamprey Ammocoete	151,992	145,878	140,415	138,973	13,897,341
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	424,028	397,828	327,231	312,904	31,290,400
Sacramento Sucker Juvenile	262,279	258,673	214,362	204,391	20,439,137
Sculpin Guild Juvenile and Adult	588,342	563,091	532,301	505,398	50,539,799

Table 3.1-9. Exceedance Summary Tables – Unimpaired Flow Conditions – All Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	566,834	495,553	422,331	404,237	40,423,701
Rainbow Trout Adult	382,450	325,815	271,445	258,266	25,826,603
Lamprey Ammocoete	233,510	168,972	153,163	150,375	15,037,538
Lamprey Spawning					
Sacramento Sucker Juvenile	511,312	384,053	306,327	293,660	29,365,987
Sacramento Sucker Juvenile	302,841	227,022	186,177	178,920	17,892,012
Sculpin Guild Juvenile and Adult	587,958	558,078	487,296	452,815	45,281,454

b) February - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	534,654	468,030	395,818	379,689	37,968,946
Rainbow Trout Adult	364,544	326,347	272,334	260,748	26,074,761
Lamprey Ammocoete	206,702	156,148	145,205	143,129	14,312,887
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	466,570	299,498	254,830	246,511	24,651,059
Sacramento Sucker Juvenile	261,912	196,260	163,336	158,344	15,834,449
Sculpin Guild Juvenile and Adult	589,294	570,708	485,866	450,954	45,095,353

c) March - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	492,110	388,397	334,832	324,631	32,463,073
Rainbow Trout Adult	349,446	274,848	234,509	228,644	22,864,397
Lamprey Ammocoete	165,075	144,895	138,318	136,856	13,685,616
Lamprey Spawning	91,239	63,712	45,055	412,40	4,123,958
Sacramento Sucker Juvenile	334,978	241,736	221,179	216,078	21,607,761
Sacramento Sucker Juvenile	209,984	165,091	144,023	140,968	14,096,789
Sculpin Guild Juvenile and Adult	588,526	528,845	434,806	405,037	40,503,719

d) April - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	63,883	39,919	27,035	24,590	2,458,995
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	420,245	315,821	286,407	280,630	28,062,968
Rainbow Trout Adult	301,790	219,789	201,664	199,193	19,919,292
Lamprey Ammocoete	153,287	138,867	133,557	132,543	13,254,255
Lamprey Spawning	70,978	39,819	28,425	26,254	2,625,420
Sacramento Sucker Juvenile	266,788	222,421	205,946	201,520	20,151,990
Sacramento Sucker Juvenile	201,987	176,481	152,398	148,542	14,854,246
Sculpin Guild Juvenile and Adult	562,904	437,229	345,959	324,778	32,477,770

e) May - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	59,084	25,984	15,627	14,192	1,419,246
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	392,271	297,097	270,545	266,240	26,623,974
Rainbow Trout Adult	284,926	215,872	200,301	198,002	19,800,243
Lamprey Ammocoete	152,293	145,464	138,294	136,809	13,680,925
Lamprey Spawning	62,805	27,934	18,572	17,100	17,09,968
Sacramento Sucker Juvenile	270,962	221,451	202,109	197,813	19,781,331
Sacramento Sucker Juvenile	209,177	190,626	174,852	168,870	16,886,980
Sculpin Guild Juvenile and Adult	540,061	337,513	247,735	234,978	23,497,776

f) June - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	72,581	55,272	33,784	30,534	3,053,423
Rainbow Trout Fry	136,919	109,708	96,165	93,755	9,375,527
Rainbow Trout Juvenile	517,991	394,114	330,904	320,564	32,056,421
Rainbow Trout Adult	355,183	279,145	237,504	231,501	23,150,145
Lamprey Ammocoete	157,989	146,271	139,639	138,059	13,805,931
Lamprey Spawning	96,189	624,22	39,403	358,41	3,584,149
Sacramento Sucker Juvenile	337,021	249,516	221,913	215,790	21,578,992
Sacramento Sucker Juvenile	234,542	197,623	168,334	162,904	16,290,386
Sculpin Guild Juvenile and Adult	586,802	511,366	365,796	341,237	34,123,686

g) July - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	121,616	115,738	105,520	102,268	10,226,774
Rainbow Trout Juvenile	523,457	493,835	428,536	409,821	40,982,113
Rainbow Trout Adult	358,223	329,131	275,942	262,604	26,260,428
Lamprey Ammocoete	232,647	167,505	152,365	149,638	14,963,775
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	456,982	377,042	303,498	290,899	29,089,926
Sacramento Sucker Juvenile	261,397	222,424	184,874	177,834	17,783,426
Sculpin Guild Juvenile and Adult	588,966	565,546	497,489	463,966	46,396,632

j) October - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	521,955	475,950	424,388	414,038	41,403,765
Rainbow Trout Adult	352,588	268,645	203,270	191,789	19,178,906
Lamprey Ammocoete	287,939	253,466	214,111	205,835	20,583,507
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,721	458,535	441,632	422,153	42,215,332
Sacramento Sucker Juvenile	261,463	227,114	200,880	195,041	19,504,135
Sculpin Guild Juvenile and Adult	577,844	491,924	429,493	417,732	41,773,199

h) August - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,713	116,370	112,562	110,049	11,004,873
Rainbow Trout Juvenile	523,526	494,202	442,171	429,505	42,950,509
Rainbow Trout Adult	357,343	310,468	241,043	226,721	22,672,096
Lamprey Ammocoete	274,858	226,917	189,679	183,537	18,353,730
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	461,143	455,048	404,208	383,937	38,393,728
Sacramento Sucker Juvenile	261,582	231,564	202,607	194,147	19,414,651
Sculpin Guild Juvenile and Adult	586,635	537,175	468,690	454,038	45,403,788

k) November - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,466	496,792	449,742	434,744	43,474,361
Rainbow Trout Adult	357,762	306,787	245,419	230,866	23,086,578
Lamprey Ammocoete	273,223	215,849	183,602	177,990	17,799,016
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	460,933	453,452	406,865	386,044	38,604,411
Sacramento Sucker Juvenile	261,730	235,797	209,724	200,834	20,083,355
Sculpin Guild Juvenile and Adult	584,238	530,438	470,242	453,314	45,331,436

i) September - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,727	116,144	112,495	111,224	11,122,393
Rainbow Trout Juvenile	521,473	477,149	426,675	416,139	41,613,856
Rainbow Trout Adult	351,858	271,724	207,064	195,271	19,527,148
Lamprey Ammocoete	287,115	249,675	210,666	202,774	20,277,366
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,622	458,218	440,010	419,423	41,942,315
Sacramento Sucker Juvenile	261,421	227,768	201,335	194,906	19,490,625
Sculpin Guild Juvenile and Adult	580,019	496,294	434,111	421,959	42,195,942

l) December - Node 1 - All Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,812	506,275	454,046	435,968	43,596,816
Rainbow Trout Adult	359,124	329,267	273,967	258,047	25,804,698
Lamprey Ammocoete	255,701	187,127	164,454	160,663	16,066,346
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,758	434,763	357,567	341,060	34,105,956
Sacramento Sucker Juvenile	265,995	237,879	203,106	194,278	19,427,777
Sculpin Guild Juvenile and Adult	587,382	555,616	497,966	475,528	47,552,794

Table 3.1-10. Exceedance Summary Tables – Unimpaired Flow Conditions – Critically Dry Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	521,225	502,184	462,277	450,615	45,061,461
Rainbow Trout Adult	358,302	304,447	246,043	232,112	23,211,184
Lamprey Ammocoete	261,736	214,647	185,115	179,422	17,942,244
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	459,511	453,245	429,409	411,680	41,168,022
Sacramento Sucker Juvenile	261,910	244,653	219,192	212,600	21,259,967
Sculpin Guild Juvenile and Adult	583,481	522,314	469,651	456,272	45,627,216

b) February - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,194	514,319	470,417	455,237	45,523,691
Rainbow Trout Adult	359,791	349,902	293,621	275,853	27,585,333
Lamprey Ammocoete	251,052	188,057	163,350	159,621	15,962,089
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	458,184	419,750	350,095	334,900	33,489,993
Sacramento Sucker Juvenile	259,852	231,265	201,171	192,697	19,269,663
Sculpin Guild Juvenile and Adult	589,029	573,854	519,762	501,186	50,118,576

c) March - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	500,872	462,245	418,099	403,177	40,317,661
Rainbow Trout Adult	354,504	332,526	290,369	278,032	27,803,173
Lamprey Ammocoete	198,759	154,917	145,830	144,020	14,402,040
Lamprey Spawning	95,273	86,295	738,06	68,764	68,76,420
Sacramento Sucker Juvenile	448,487	284,275	248,275	242,695	24,269,508
Sacramento Sucker Juvenile	220,827	160,379	141,818	138,999	13,899,906
Sculpin Guild Juvenile and Adult	589,391	585,517	543,362	522,534	52,253,373

d) April - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	71,606	57,373	43,923	40,388	4,038,797
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	472,862	378,363	332,245	323,259	32,325,931
Rainbow Trout Adult	341,195	268,883	231,874	226,377	22,637,723
Lamprey Ammocoete	157,344	141,612	136,681	135,407	13,540,707
Lamprey Spawning	86,968	61,376	45,715	42,404	4,240,369
Sacramento Sucker Juvenile	279,145	230,922	216,987	213,029	21,302,924
Sacramento Sucker Juvenile	193,520	147,670	133,615	131,577	13,157,741
Sculpin Guild Juvenile and Adult	589,221	528,139	454,475	429,719	42,971,897

e) May - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	71,228	53,518	39,367	36,208	3,620,788
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	477,631	360,751	318,522	310,713	31,071,294
Rainbow Trout Adult	342,718	257,677	223,511	218,871	21,887,090
Lamprey Ammocoete	147,742	139,228	134,579	133,488	13,348,768
Lamprey Spawning	86,118	55,502	40,501	37,652	3,765,168
Sacramento Sucker Juvenile	246,116	220,729	209,523	206,120	20,611,988
Sacramento Sucker Juvenile	191,537	152,233	136,487	134,149	13,414,870
Sculpin Guild Juvenile and Adult	585,159	512,019	429,936	40,6683	40,668,272

f) June - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	73,683	70,191	63,949	59,409	5,940,894
Rainbow Trout Fry	118,077	111,577	101,871	99,236	9,923,624
Rainbow Trout Juvenile	524,202	498,131	437,784	419,795	41,979,504
Rainbow Trout Adult	359,459	343,568	304,808	292,595	29,259,498
Lamprey Ammocoete	159,678	146,336	140,173	138,801	13,880,132
Lamprey Spawning	96,999	91,937	76,646	70,964	7,096,379
Sacramento Sucker Juvenile	400,166	294,041	252,986	246,016	24,601,608
Sacramento Sucker Juvenile	253,174	202,219	165,067	159,922	15,992,188
Sculpin Guild Juvenile and Adult	589,162	577,902	550,078	523,547	52,354,727

g) July - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,774	117,705	114,672	112,910	11,291,023
Rainbow Trout Juvenile	523,729	505,963	461,877	449,286	44,928,580
Rainbow Trout Adult	356,897	315,021	254,568	239,490	23,948,994
Lamprey Ammocoete	267,394	212,233	181,758	176,520	17,652,010
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	460,211	453,158	415,829	396,269	39,626,916
Sacramento Sucker Juvenile	261,913	244,577	218,173	209,317	20,931,686
Sculpin Guild Juvenile and Adult	582,432	535,069	479,431	464,695	46,469,452

h) August - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	116,640	112,281	110,150	109,656	10,965,579
Rainbow Trout Juvenile	461,905	405,022	379,441	373,772	37,377,237
Rainbow Trout Adult	226,496	162,612	138,461	133,565	13,356,491
Lamprey Ammocoete	286,250	263,613	243,548	236,651	23,665,135
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,518	459,725	457,042	455,771	45,577,130
Sacramento Sucker Juvenile	224,634	195,238	182,355	179,524	17,952,366
Sculpin Guild Juvenile and Adult	451,047	394,210	369,063	363,507	36,350,689

i) September - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	116,001	109,955	108,095	107,775	10,777,536
Rainbow Trout Juvenile	472,203	381,791	358,306	354,416	35,441,574
Rainbow Trout Adult	256,268	145,838	122,808	119,233	11,923,310
Lamprey Ammocoete	289,588	280,721	265,712	256,167	25,616,681
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,918	461,854	459,951	455,862	45,586,199
Sacramento Sucker Juvenile	226,367	182,526	171,176	169,297	16,929,675
Sculpin Guild Juvenile and Adult	479,744	375,220	350,477	346,452	34,645,167

j) October - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,023	465,054	405,053	396,505	39,650,456
Rainbow Trout Adult	344,049	247,063	179,424	170,199	17,019,932
Lamprey Ammocoete	289,480	279,898	235,780	225,827	22,582,689
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,905	461,751	450,507	437,391	43,739,120
Sacramento Sucker Juvenile	261,590	224,142	194,382	190,126	19,012,614
Sculpin Guild Juvenile and Adult	560,159	468,906	403,003	393,741	39,374,121

k) November - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	518,243	473,344	431,427	420,629	42,062,881
Rainbow Trout Adult	327,684	248,869	198,790	187,911	18,791,124
Lamprey Ammocoete	285,745	241,159	210,195	203,240	20,324,018
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,458	457,212	448,733	440,838	44,083,758
Sacramento Sucker Juvenile	261,901	232,072	209,508	203,989	20,398,945
Sculpin Guild Juvenile and Adult	538,435	470,018	424,899	413,827	41,382,660

l) December - Node 1 – Critically Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,746	494,354	449,224	436,493	43,649,255
Rainbow Trout Adult	352,685	297,332	239,331	225,374	22,537,432
Lamprey Ammocoete	273,041	218,367	186,761	181,243	18,124,282
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	460,909	453,700	420,474	399,308	39,930,762
Sacramento Sucker Juvenile	261,870	238,989	213,315	203,922	20,392,203
Sculpin Guild Juvenile and Adult	578,193	520,678	466,455	452,501	45,250,078

Table 3.1-11. Exceedance Summary Tables – Unimpaired Flow Conditions – Dry Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,390	520,290	498,428	482,503	48,250,293
Rainbow Trout Adult	360,012	356,939	326,744	311,611	31,161,084
Lamprey Ammocoete	198,571	156,060	144,212	142,403	14,240,311
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	452,611	375,835	325,763	314,011	31,401,050
Sacramento Sucker Juvenile	259,584	234,418	208,855	199,805	19,980,513
Sculpin Guild Juvenile and Adult	588,214	578,346	549,220	534,127	53,412,686

b) February - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,975	507,069	476,254	459,303	45,930,333
Rainbow Trout Adult	359,734	354,283	338,284	326,206	32,620,579
Lamprey Ammocoete	148,536	140,305	135,799	134,849	13,484,875
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	344,450	278,065	251,624	245,672	24,567,224
Sacramento Sucker Juvenile	247,791	191,528	163,923	159,040	15,904,011
Sculpin Guild Juvenile and Adult	589,440	587,656	577,835	563,096	56,309,636

c) March - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	491,217	412,525	361,933	351,089	35,108,907
Rainbow Trout Adult	352,213	302,670	259,695	251,499	25,149,913
Lamprey Ammocoete	149,026	143,948	138,759	137,371	13,737,102
Lamprey Spawning	89,413	70,566	55,475	515,29	5,152,864
Sacramento Sucker Juvenile	247,374	221,771	210,851	208,437	20,843,673
Sacramento Sucker Juvenile	170,666	137,253	127,558	126,100	12,609,994
Sculpin Guild Juvenile and Adult	587,915	568,663	509,854	484,832	48,483,159

d) April - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	59,710	43,249	30,266	27,773	2,777,294
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	370,283	313,420	286,989	281,473	28,147,251
Rainbow Trout Adult	273,455	219,732	201,646	199,197	19,919,699
Lamprey Ammocoete	147,427	137,815	132,918	131,964	13,196,412
Lamprey Spawning	60,321	41,492	30,325	28,303	2,830,261
Sacramento Sucker Juvenile	221,693	211,690	200,575	197,118	19,711,846
Sacramento Sucker Juvenile	185,434	165,199	144,016	140,967	14,096,716
Sculpin Guild Juvenile and Adult	553,153	460,885	372,673	352,067	35,206,711

e) May - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	39,435	22,935	16,086	14,836	1,483,605
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	297,848	268,964	256,135	253,309	25,330,906
Rainbow Trout Adult	204,271	186,784	183,018	182,416	18,241,631
Lamprey Ammocoete	138,783	132,526	128,758	128,217	12,821,695
Lamprey Spawning	36,735	23,187	18,164	17,169	1,716,879
Sacramento Sucker Juvenile	220,753	202,573	190,432	187,289	18,728,862
Sacramento Sucker Juvenile	186,061	182,720	166,398	161,292	16,129,169
Sculpin Guild Juvenile and Adult	440,515	330,246	269,983	257,487	25,748,668

f) June - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	73,617	69,277	57,824	53,265	5,326,491
Rainbow Trout Fry	116,048	104,253	94,324	92,123	9,212,297
Rainbow Trout Juvenile	519,259	462,135	396,263	381,759	38,175,937
Rainbow Trout Adult	358,328	330,440	281,757	271,320	27,132,017
Lamprey Ammocoete	148,283	142,183	137,277	135,999	13,599,941
Lamprey Spawning	96,322	82,655	64,493	59,555	5,955,510
Sacramento Sucker Juvenile	324,174	247,918	226,463	222,363	22,236,312
Sacramento Sucker Juvenile	231,984	164,543	143,360	140,364	14,036,386
Sculpin Guild Juvenile and Adult	589,336	579,723	526,019	498,191	49,819,083

g) July - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,815	118,372	116,898	115,968	11,596,755
Rainbow Trout Juvenile	524,394	517,616	496,777	486,615	48,661,499
Rainbow Trout Adult	357,175	335,381	294,892	280,502	28,050,163
Lamprey Ammocoete	220,195	175,319	159,147	156,143	15,614,267
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	456,527	439,234	401,243	386,780	38,677,966
Sacramento Sucker Juvenile	262,185	255,729	237,746	229,845	22,984,479
Sculpin Guild Juvenile and Adult	584,579	548,726	511,608	498,878	49,887,822

h) August - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	117,103	113,179	110,847	110,357	11,035,713
Rainbow Trout Juvenile	466,500	415,704	387,595	381,899	38,189,929
Rainbow Trout Adult	230,355	173,150	146,114	141,026	14,102,645
Lamprey Ammocoete	277,555	257,639	236,167	229,454	22,945,351
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	461,476	459,041	456,192	454,915	45,491,505
Sacramento Sucker Juvenile	226,358	200,351	186,294	183,458	18,345,813
Sculpin Guild Juvenile and Adult	454,332	404,394	376,889	371,320	37,131,964

i) September - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	117,433	112,184	109,780	109,198	10,919,849
Rainbow Trout Juvenile	487,041	408,361	378,578	372,683	37,268,283
Rainbow Trout Adult	285,189	174,853	143,147	137,555	13,755,457
Lamprey Ammocoete	289,483	269,771	247,312	238,014	23,801,440
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,906	460,494	457,451	450,540	45,053,959
Sacramento Sucker Juvenile	240,045	196,653	181,428	178,175	17,817,504
Sculpin Guild Juvenile and Adult	510,870	406,252	373,099	366,833	36,683,302

j) October - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,512	486,349	438,008	424,541	42,454,138
Rainbow Trout Adult	358,518	286,022	223,411	210,151	21,015,087
Lamprey Ammocoete	284,926	234,885	198,253	191,114	19,111,355
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,360	456,396	426,389	405,842	40,584,166
Sacramento Sucker Juvenile	260,439	228,753	204,375	197,954	19,795,440
Sculpin Guild Juvenile and Adult	583,189	508,332	447,236	432,611	43,261,141

k) November - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,145	478,605	424,761	409,223	40,922,302
Rainbow Trout Adult	357,458	300,108	236,336	222,468	22,246,845
Lamprey Ammocoete	274,408	221,228	184,893	179,054	17,905,430
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	461,092	452,606	376,933	358,231	35,823,102
Sacramento Sucker Juvenile	260,042	220,463	190,936	183,326	18,332,560
Sculpin Guild Juvenile and Adult	585,775	533,535	463,143	444,408	44,440,763

l) December - Node 1 – Dry Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,578	478,513	420,894	405,913	40,591,320
Rainbow Trout Adult	355,118	314,510	264,042	250,239	25,023,903
Lamprey Ammocoete	239,860	178,891	160,062	156,879	15,687,880
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	456,771	398,954	316,679	304,287	30,428,744
Sacramento Sucker Juvenile	259,406	215,843	175,871	169,668	16,966,836
Sculpin Guild Juvenile and Adult	588,781	556,935	497,991	475,884	47,588,374

Table 3.1-12. Exceedance Summary Tables – Unimpaired Flow Conditions – Below Normal Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,733	457,998	387,311	372,321	37,232,118
Rainbow Trout Adult	353,842	311,447	260,458	250,101	25,010,085
Lamprey Ammocoete	207,724	156,672	146,177	143,987	14,398,740
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	452,214	310,110	260,520	252,011	25,201,050
Sacramento Sucker Juvenile	257,479	201,995	166,029	160,734	16,073,412
Sculpin Guild Juvenile and Adult	588,274	558,351	479,272	446,512	44,651,241

b) February - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	463,188	370,322	326,325	316,897	31,689,674
Rainbow Trout Adult	337,017	268,455	233,101	227,527	22,752,666
Lamprey Ammocoete	148,414	143,322	138,156	136,774	13,677,364
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	238,211	217,898	207,460	203,631	20,363,142
Sacramento Sucker Juvenile	188,841	153,317	136,394	134,041	13,404,148
Sculpin Guild Juvenile and Adult	585,837	535,457	444,593	413,277	41,327,689

c) March - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	352,977	316,621	296,274	291,449	29,144,924
Rainbow Trout Adult	258,767	222,622	204,916	202,175	20,217,548
Lamprey Ammocoete	145,880	138,139	134,659	133,697	13,369,659
Lamprey Spawning	557,68	43,531	35,008	32,938	32,93,757
Sacramento Sucker Juvenile	222,450	218,098	210,173	207,349	20,734,945
Sacramento Sucker Juvenile	171,426	136,231	126,932	125,548	12,554,765
Sculpin Guild Juvenile and Adult	538,368	477,210	421,884	403,097	40,309,712

d) April - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	50065	35,591	26,401	24,269	2,426,890
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	326,706	291,906	275,774	271,328	27,132,846
Rainbow Trout Adult	232,300	200,281	190,586	189,224	18,922,399
Lamprey Ammocoete	140,735	134,417	131,093	130,330	13,032,971
Lamprey Spawning	47,488	33,593	26,187	24,550	2,455,020
Sacramento Sucker Juvenile	221,165	213,858	203,487	199,820	19,982,040
Sacramento Sucker Juvenile	185,527	161,824	143,182	140,217	14,021,749
Sculpin Guild Juvenile and Adult	500,473	416,792	352,606	333,691	33,369,133

e) May - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	18,695	8,206	5,374	4,967	496,652
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	282,013	255,299	243,859	242,221	24,222,079
Rainbow Trout Adult	213,215	194,953	188,967	187,795	18,779,539
Lamprey Ammocoete	150,359	145,903	140,112	138,449	13,844,888
Lamprey Spawning	19,858	12,015	92,55	8,749	874,934
Sacramento Sucker Juvenile	238,072	203,053	188,379	185,319	18,531,889
Sacramento Sucker Juvenile	197,635	188,356	186,079	182,586	18,258,577
Sculpin Guild Juvenile and Adult	302,130	196,360	165,116	160,646	16,064,606

f) June - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	49,070	35,176	24,197	22,045	2,204,457
Rainbow Trout Fry	94,208	82,055	78,053	77,420	7,741,996
Rainbow Trout Juvenile	324,176	290,814	271,638	267,377	26,737,725
Rainbow Trout Adult	229,782	200,573	190,976	18,9597	18,959,733
Lamprey Ammocoete	143,786	136,012	131,772	13,0933	13,093,307
Lamprey Spawning	46,536	33,221	24,639	22,879	2,287,943
Sacramento Sucker Juvenile	222,643	214,807	200,811	197,368	19,736,831
Sacramento Sucker Juvenile	186,724	174,834	150,842	147,168	14,716,849
Sculpin Guild Juvenile and Adult	495,316	414,331	331,159	311,543	31,154,297

g) July - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,531	112,135	105,467	103,602	10,360,176
Rainbow Trout Juvenile	523,363	506,498	466,869	454,398	45,439,839
Rainbow Trout Adult	359,767	350,515	329,727	321,544	32,154,445
Lamprey Ammocoete	148,796	144,018	138,898	137,674	13,767,383
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	379,937	289,179	252,585	246,680	24,667,998
Sacramento Sucker Juvenile	260,362	196,500	163,499	158,572	15,857,212
Sculpin Guild Juvenile and Adult	589,450	585,498	573,208	567,132	56,713,168

j) October - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	518,670	457,803	417,681	408,433	40,843,334
Rainbow Trout Adult	322,071	228,051	182,386	173,275	17,327,537
Lamprey Ammocoete	284,506	247,911	219,535	211,788	21,178,757
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,309	457,788	451,732	444,669	44,466,890
Sacramento Sucker Juvenile	261,388	224,966	203,289	198,485	19,848,476
Sculpin Guild Juvenile and Adult	529,937	451,489	409,597	400,226	40,022,594

h) August - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,802	118,478	117,366	116,531	11,653,131
Rainbow Trout Juvenile	524,059	515,951	495,503	487,403	48,740,314
Rainbow Trout Adult	355,831	326,797	288,747	276,888	27,688,815
Lamprey Ammocoete	203,409	172,087	158,436	155,635	15,563,462
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	455,599	441,184	411,252	396,665	39,666,537
Sacramento Sucker Juvenile	262,106	257,068	241,009	234,017	23,401,724
Sculpin Guild Juvenile and Adult	580,096	539,675	505,537	495,305	49,530,500

k) November - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	515,322	476,544	447,923	439,513	43,951,264
Rainbow Trout Adult	338,836	264,713	222,891	212,788	21,278,837
Lamprey Ammocoete	244,592	209,347	188,616	183,506	18,350,623
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	457,844	453,763	444,825	425,775	42,577,472
Sacramento Sucker Juvenile	258,983	231,149	214,244	207,033	20,703,273
Sculpin Guild Juvenile and Adult	577,493	490,466	451,701	441,892	44,189,226

i) September - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,692	117,449	115,542	114,909	11,490,903
Rainbow Trout Juvenile	509,083	476,173	448,863	440,669	44,066,854
Rainbow Trout Adult	298,846	245,801	212,491	203,676	20,367,564
Lamprey Ammocoete	240,062	208,502	190,052	185,615	18,561,544
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	457,176	454,375	448,896	445,009	44,500,922
Sacramento Sucker Juvenile	259,853	234,311	218,852	214,556	21,455,560
Sculpin Guild Juvenile and Adult	509,867	466,815	438,602	430,406	43,040,561

l) December - Node 1 – Below Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,557	508,195	476,763	459,031	45,903,105
Rainbow Trout Adult	359,377	327,574	280,085	268,636	26,863,572
Lamprey Ammocoete	205,060	173,075	156,871	153,869	15,386,917
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	454,866	440,694	375,807	358,117	35,811,652
Sacramento Sucker Juvenile	261,796	241,876	216,461	206,454	20,645,431
Sculpin Guild Juvenile and Adult	586,024	551,248	505,372	491,572	49,157,162

Table 3.1-13. Exceedance Summary Tables – Unimpaired Flow Conditions – Above Normal Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	505,366	462,312	432,341	421,310	42,130,951
Rainbow Trout Adult	357,765	336,657	317,322	308,405	30,840,469
Lamprey Ammocoete	149,278	145,570	141,579	140,163	14,016,288
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	259,178	228,846	215,627	213,471	21,347,123
Sacramento Sucker Juvenile	171,860	138,715	129,232	127,745	12,774,496
Sculpin Guild Juvenile and Adult	589,270	586,190	578,620	569,708	56,970,837

b) February - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	488,614	472,444	448,717	440,250	44,025,025
Rainbow Trout Adult	351,368	343,370	328,862	322,817	32,281,747
Lamprey Ammocoete	147,960	143,682	139,705	138,848	13,884,769
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	245,310	233,187	219,830	217,233	21,723,274
Sacramento Sucker Juvenile	149,511	138,471	130,521	128,978	12,897,810
Sculpin Guild Juvenile and Adult	589,505	589,190	584,791	581,209	58,120,935

c) March - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	497,342	464,106	402,491	388,998	38,899,756
Rainbow Trout Adult	354,980	337,061	290,107	279,105	27,910,538
Lamprey Ammocoete	148,258	141,934	137,192	136,308	13,630,776
Lamprey Spawning	90,907	82,980	66,625	62,240	6,223,963
Sacramento Sucker Juvenile	252,037	236,111	220,779	218,074	21,807,404
Sacramento Sucker Juvenile	159,624	142,012	130,660	128,893	12,889,279
Sculpin Guild Juvenile and Adult	589,509	584,746	541,939	521,829	52,182,882

d) April - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	51,483	40,872	34,788	32,574	3,257,430
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	331,374	302,316	289,717	285,708	28,570,766
Rainbow Trout Adult	237,074	208,806	198,037	196,028	19,602,828
Lamprey Ammocoete	141,540	135,294	133,388	132,773	13,277,306
Lamprey Spawning	49,170	38,316	32,811	31,060	31,05,966
Sacramento Sucker Juvenile	221,892	220,190	214,307	211,173	21,117,292
Sacramento Sucker Juvenile	166,699	131,977	124,589	123,491	12,349,057
Sculpin Guild Juvenile and Adult	509,002	448,680	412,246	395,648	39,564,771

e) May - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	31,558	21,517	13,699	12,459	1,245,879
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	283,923	270,403	256,402	253,512	25,351,211
Rainbow Trout Adult	208,844	191,966	186,603	185,700	18,569,979
Lamprey Ammocoete	149,982	140,344	135,190	134,041	13,404,104
Lamprey Spawning	295,72	217,89	15,842	14,690	14,69,048
Sacramento Sucker Juvenile	2302,72	215,446	197,996	193,890	19,388,950
Sacramento Sucker Juvenile	193,764	186,945	168,139	163,158	16,315,824
Sculpin Guild Juvenile and Adult	394,500	322,028	245,514	233,005	23,300,454

f) June - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	59,860	31,842	20,388	18,549	1,854,905
Rainbow Trout Fry	101,559	86,863	80,893	79,984	7,998,424
Rainbow Trout Juvenile	370,447	292,793	268,323	264,242	26,424,221
Rainbow Trout Adult	273,752	209,130	195,763	193,895	19,389,476
Lamprey Ammocoete	148,304	140,681	134,732	133,603	13,360,331
Lamprey Spawning	60,406	31,985	22,456	20,810	2,081,025
Sacramento Sucker Juvenile	217,580	202,244	189,240	185,731	18,573,070
Sacramento Sucker Juvenile	186,012	183,321	162,713	157,934	15,793,363
Sculpin Guild Juvenile and Adult	554,720	386,567	292,889	276,395	27,639,480

g) July - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	116,560	113,302	107,123	104,807	10,480,657
Rainbow Trout Juvenile	524,084	515,257	479,668	464,286	46,428,569
Rainbow Trout Adult	359,870	356,504	340,224	329,346	32,934,619
Lamprey Ammocoete	147,052	140,253	135,571	134,634	13,463,416
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	311,660	280,895	251,921	246,368	24,636,840
Sacramento Sucker Juvenile	237,351	202,376	168,614	163,281	16,328,096
Sculpin Guild Juvenile and Adult	589,171	584,493	576,760	568,573	56,857,281

j) October - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	516,979	465,257	417,872	408,285	40,828,518
Rainbow Trout Adult	357,439	268,979	205,753	194,073	19,407,282
Lamprey Ammocoete	287,076	251,445	212,342	204,026	20,402,575
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,617	458,689	430,962	408,308	40,830,774
Sacramento Sucker Juvenile	239,963	213,580	190,602	183,684	18,368,406
Sculpin Guild Juvenile and Adult	582,354	502,640	437,923	425,407	42,540,671

h) August - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,535	117,111	114,784	114,072	11,407,196
Rainbow Trout Juvenile	518,939	482,054	449,436	439,632	43,963,232
Rainbow Trout Adult	350,461	265,314	220,568	209,649	20,964,874
Lamprey Ammocoete	255,581	215,463	192,470	186,527	18,652,669
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	458,751	454,882	446,127	431,774	43,177,390
Sacramento Sucker Juvenile	258,889	231,287	213,781	208,833	20,883,300
Sculpin Guild Juvenile and Adult	568,530	486,023	446,656	436,138	43,613,758

k) November - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,722	519,801	508,863	500,646	50,064,625
Rainbow Trout Adult	359,861	355,775	327,839	313,416	31,341,640
Lamprey Ammocoete	194,332	158,396	145,921	143,963	14,396,263
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	454,429	413,774	357,845	347,178	34,717,761
Sacramento Sucker Juvenile	262,097	250,222	228,387	221,380	22,138,014
Sculpin Guild Juvenile and Adult	586,236	573,773	543,374	530,531	53,053,125

i) September - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	117,469	114,618	112,475	111,989	11,198,929
Rainbow Trout Juvenile	473,853	433,930	407,222	401,390	40,138,997
Rainbow Trout Adult	240,322	192,489	164,992	159,421	15,942,131
Lamprey Ammocoete	256,910	237,109	217,877	212,577	21,257,719
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	458,903	456,737	453,803	452,451	45,245,059
Sacramento Sucker Juvenile	232,612	209,743	196,223	193,297	19,329,667
Sculpin Guild Juvenile and Adult	462,294	422,328	396,135	390,425	39,042,531

l) December - Node 1 – Above Normal Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,743	518,956	499,077	478,659	47,865,852
Rainbow Trout Adult	359,669	349,991	329,321	317,362	31,736,152
Lamprey Ammocoete	146,558	142,953	138,162	137,006	13,700,634
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	412,197	369,760	315,371	302,943	30,294,291
Sacramento Sucker Juvenile	262,251	254,147	215,348	205,348	20,534,822
Sculpin Guild Juvenile and Adult	588,399	575,377	551,611	536,620	53,662,014

Table 3.1-14. Exceedance Summary Tables – Unimpaired Flow Conditions – Wet Water Years. Exceedance percentile values are total habitat in square feet.

a) January - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	562,781	421,894	357,219	344,577	34,457,723
Rainbow Trout Adult	380,744	296,881	251,650	244,242	24,424,193
Lamprey Ammocoete	161,546	146,612	140,046	138,469	13,846,905
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	421,852	267,757	235,709	229,030	22,903,023
Sacramento Sucker Juvenile	285,755	195,913	161,193	156,387	15,638,740
Sculpin Guild Juvenile and Adult	587,682	541,740	431,824	400,629	40,062,875

b) February - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	466,691	372,079	321,905	312,646	31,264,562
Rainbow Trout Adult	335,162	269,369	231,976	226,524	22,652,434
Lamprey Ammocoete	156,581	146,386	139,611	138,002	13,800,207
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	325,232	232,950	213,008	208,221	20,822,062
Sacramento Sucker Juvenile	231,894	179,674	151,855	147,989	14,798,931
Sculpin Guild Juvenile and Adult	584,608	522,291	395,295	367,792	36,779,208

c) March - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	347,191	291,141	271,113	266,778	26,677,833
Rainbow Trout Adult	246,272	202,365	192,049	190,549	19,054,949
Lamprey Ammocoete	152,878	139,180	133,900	132,852	13,285,187
Lamprey Spawning	42,622	28,756	21,042	19,367	1,936,652
Sacramento Sucker Juvenile	280,335	226,436	207,462	202,837	20,283,734
Sacramento Sucker Juvenile	212,123	185,485	159,948	155,405	15,540,529
Sculpin Guild Juvenile and Adult	472,856	380,953	297,052	279,448	27,944,809

d) April - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	33,929	19,032	12,986	11,823	1,182,287
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	323,927	272,540	257,324	254,342	25,434,217
Rainbow Trout Adult	226,230	192,715	186,230	185,295	18,529,494
Lamprey Ammocoete	151,764	138,009	132,062	131,193	13,119,289
Lamprey Spawning	31,745	20,140	15,620	14,513	1,451,303
Sacramento Sucker Juvenile	269,611	212,608	195,995	192,151	19,215,078
Sacramento Sucker Juvenile	207,896	189,001	173,945	168,274	16,827,402
Sculpin Guild Juvenile and Adult	408,343	302,488	242,886	230,708	23,070,816

e) May - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	13,806	5,726	3,794	3,540	353,974
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	333,554	275,582	256,434	253,538	2,535,813
Rainbow Trout Adult	243,459	209,738	198,145	196,188	19,618,771
Lamprey Ammocoete	154,649	149,793	144,244	142,203	14,220,269
Lamprey Spawning	16,415	9,868	7,579	7,145	714,478
Sacramento Sucker Juvenile	299,537	232,008	206,675	201,886	20,188,565
Sacramento Sucker Juvenile	218,611	195,902	191,152	189,025	18,902,492
Sculpin Guild Juvenile and Adult	255,266	168,885	147,766	144,952	14,495,247

f) June - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	39,495	13,464	8,162	7,471	747,116
Rainbow Trout Fry	148,523	118,637	102,212	99,221	9,922,069
Rainbow Trout Juvenile	338,612	288,722	263,842	260,206	26,020,636
Rainbow Trout Adult	247,429	213,821	200,157	197,913	19,791,253
Lamprey Ammocoete	154,342	149,033	143,111	141,222	14,122,167
Lamprey Spawning	37,987	16,304	11,264	10,464	1,046,375
Sacramento Sucker Juvenile	295,236	236,831	209,600	204,414	20,441,373
Sacramento Sucker Juvenile	216,977	196,941	188,648	181,686	18,168,599
Sculpin Guild Juvenile and Adult	438,578	234,503	184,911	178,386	17,838,574

g) July - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	119,856	101,024	90,069	88,252	88,25,202
Rainbow Trout Juvenile	493,776	393,545	334,658	324,148	32,414,776
Rainbow Trout Adult	353,018	285,541	240,828	234,476	23,447,597
Lamprey Ammocoete	150,143	142,613	136,840	135,510	13,550,974
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	257,057	225,522	210,455	205,972	20,597,184
Sacramento Sucker Juvenile	194,715	171,654	148,801	145,274	14,527,401
Sculpin Guild Juvenile and Adult	589,002	538,751	416,905	387,505	38,750,456

j) October - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	522,427	482,427	433,256	423,025	42,302,541
Rainbow Trout Adult	354,557	285,245	216,810	204,726	20,472,648
Lamprey Ammocoete	277,795	241,754	204,723	197,324	19,732,411
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	461,500	456,857	432,929	412,747	41,274,731
Sacramento Sucker Juvenile	261,738	229,158	203,708	196,998	19,699,795
Sculpin Guild Juvenile and Adult	584,015	509,099	444,497	432,255	43,225,546

h) August - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,753	117,116	109,738	106,536	10,653,617
Rainbow Trout Juvenile	524,098	516,174	477,456	458,722	45,872,151
Rainbow Trout Adult	359,498	347,258	316,273	303,282	30,328,244
Lamprey Ammocoete	172,636	149,491	142,102	140,581	14,058,100
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	441,598	366,413	304,831	293,742	29,374,201
Sacramento Sucker Juvenile	261,852	242,169	196,819	188,560	18,856,005
Sculpin Guild Juvenile and Adult	589,149	575,515	548,287	531,904	53,190,357

k) November - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	524,301	512,788	463,992	445,546	44,554,571
Rainbow Trout Adult	359,483	333,774	277,386	260,674	26,067,377
Lamprey Ammocoete	258,922	190,049	166,228	162,228	16,222,826
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	459,169	436,385	368,854	350,877	35,087,666
Sacramento Sucker Juvenile	261,827	243,003	211,546	202,009	20,200,893
Sculpin Guild Juvenile and Adult	586,275	556,196	499,475	478,154	47,815,439

i) September - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	118,792	117,951	114,820	112,415	11,241,467
Rainbow Trout Juvenile	524,150	511,455	478,259	465,067	46,506,722
Rainbow Trout Adult	358,199	331,624	284,270	269,655	26,965,496
Lamprey Ammocoete	229,424	181,678	162,640	159,112	15,911,172
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	455,980	440,583	385,160	366,768	36,676,773
Sacramento Sucker Juvenile	262,074	248,385	220,094	210,074	21,007,449
Sculpin Guild Juvenile and Adult	587,905	555,319	509,014	494,009	49,400,865

l) December - Node 1 - Wet Water Years - Unimpaired Flow Conditions

Species/Lifestage	Exceedance Percentile or Metric				Total AUC
	10%	50%	90%	Whole Series Mean	
Rainbow Trout Spawning	--	--	--	--	--
Rainbow Trout Fry	--	--	--	--	--
Rainbow Trout Juvenile	523,934	513,729	455,201	434,973	43,497,327
Rainbow Trout Adult	359,758	342,957	288,404	270,794	27,079,363
Lamprey Ammocoete	256,516	178,369	157,880	154,652	15,465,228
Lamprey Spawning	--	--	--	--	--
Sacramento Sucker Juvenile	462,998	403,211	332,219	317,709	31,770,860
Sacramento Sucker Juvenile	265,959	235,918	201,504	192,885	19,288,517
Sculpin Guild Juvenile and Adult	587,664	566,701	504,372	474,179	47,417,863

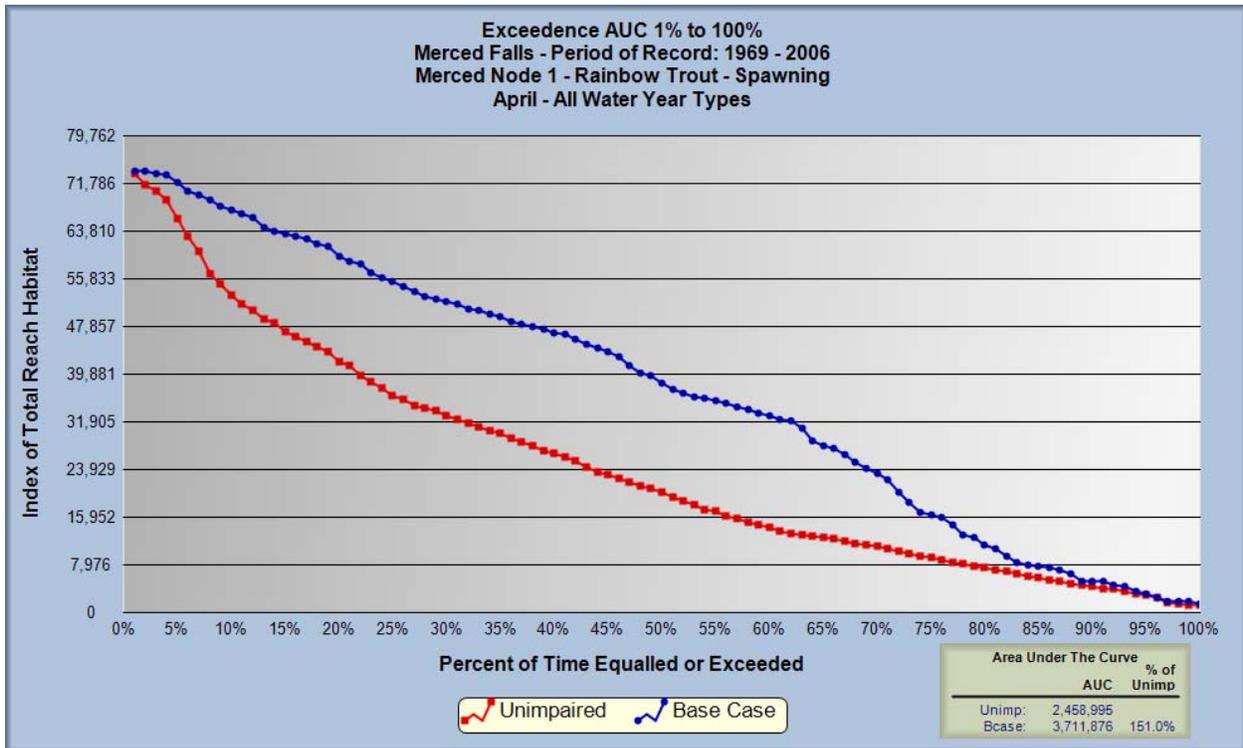


Figure 3.1-5. Habitat exceedance for rainbow trout spawning in April.

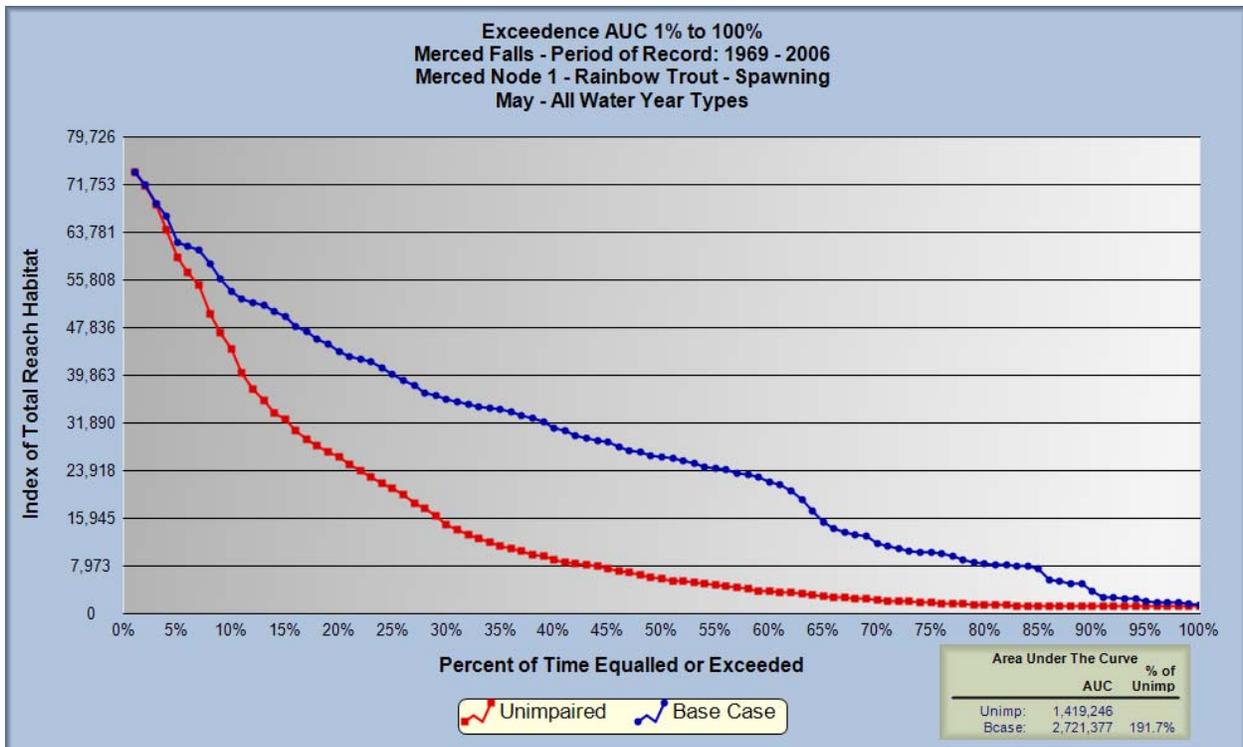


Figure 3.1-6. Habitat exceedance for rainbow trout spawning in May.

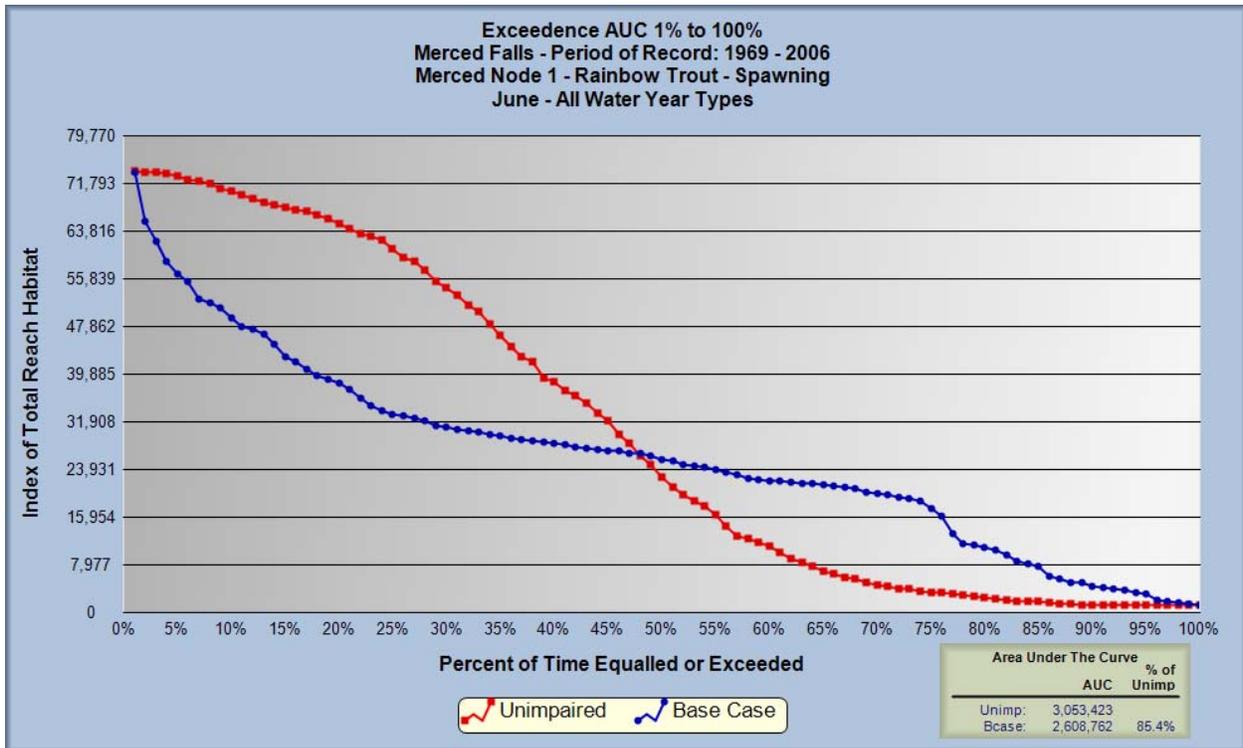


Figure 3.1-7. Habitat exceedance for rainbow trout spawning in June.

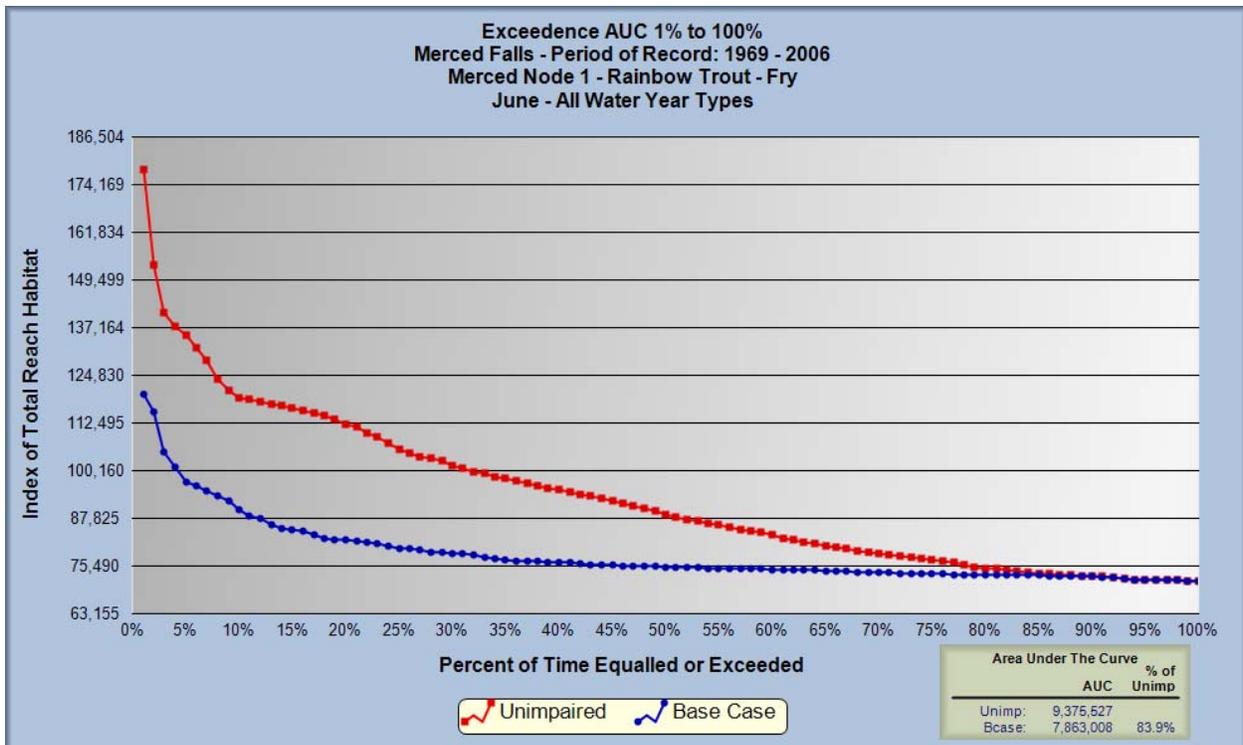


Figure 3.1-8. Habitat exceedance for rainbow trout fry in June.

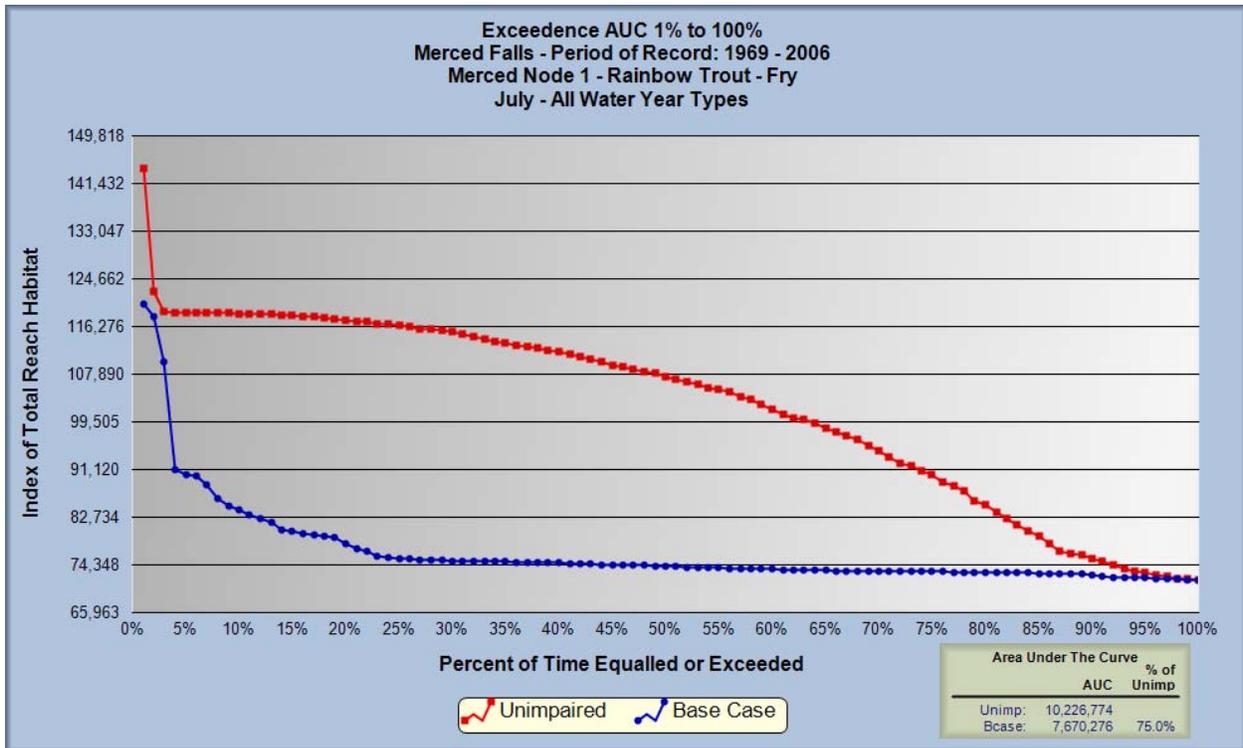


Figure 3.1-9. Habitat exceedance for rainbow trout fry in July.

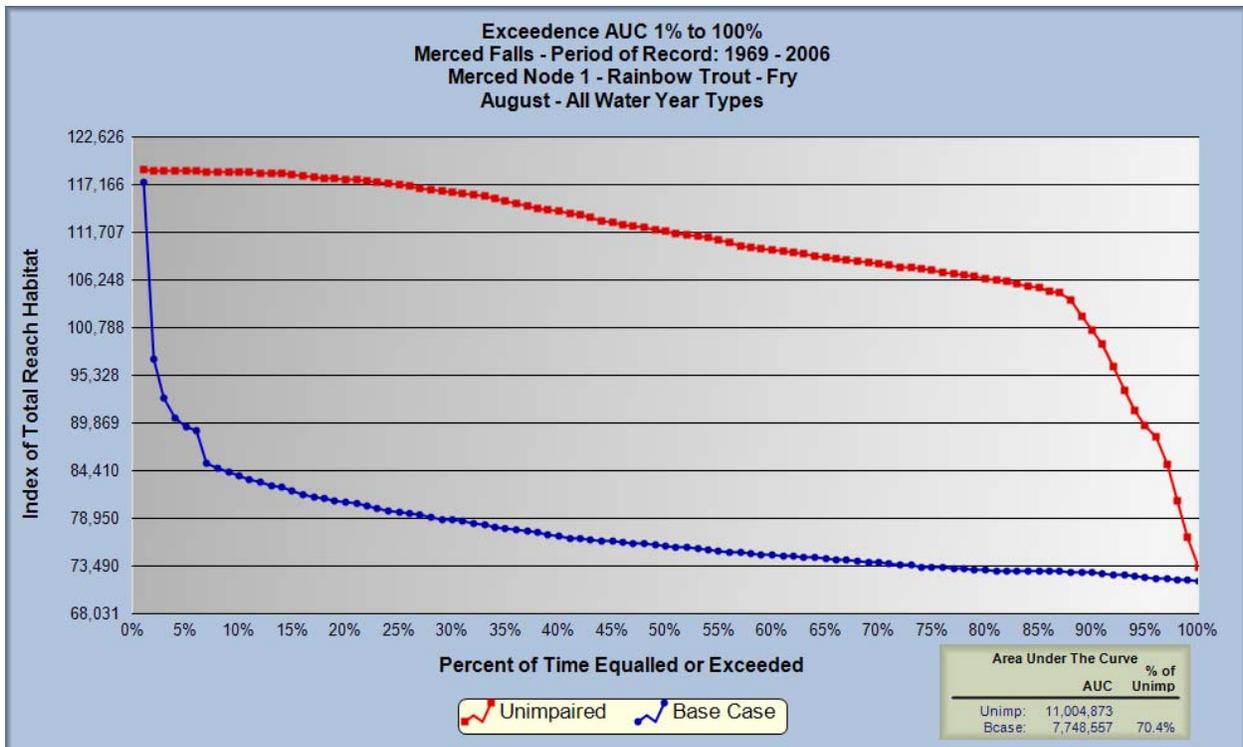


Figure 3.1-10. Habitat exceedance for rainbow trout fry in August.

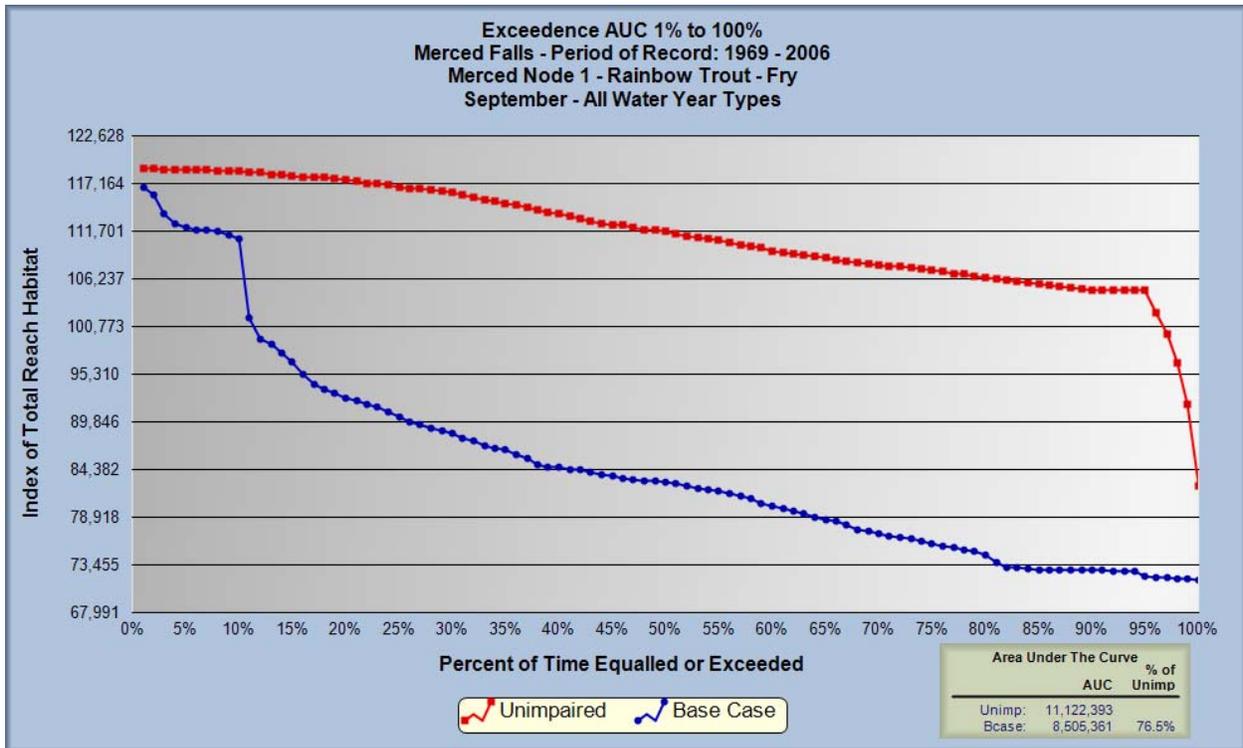


Figure 3.1-11. Habitat exceedance for rainbow trout fry in September.

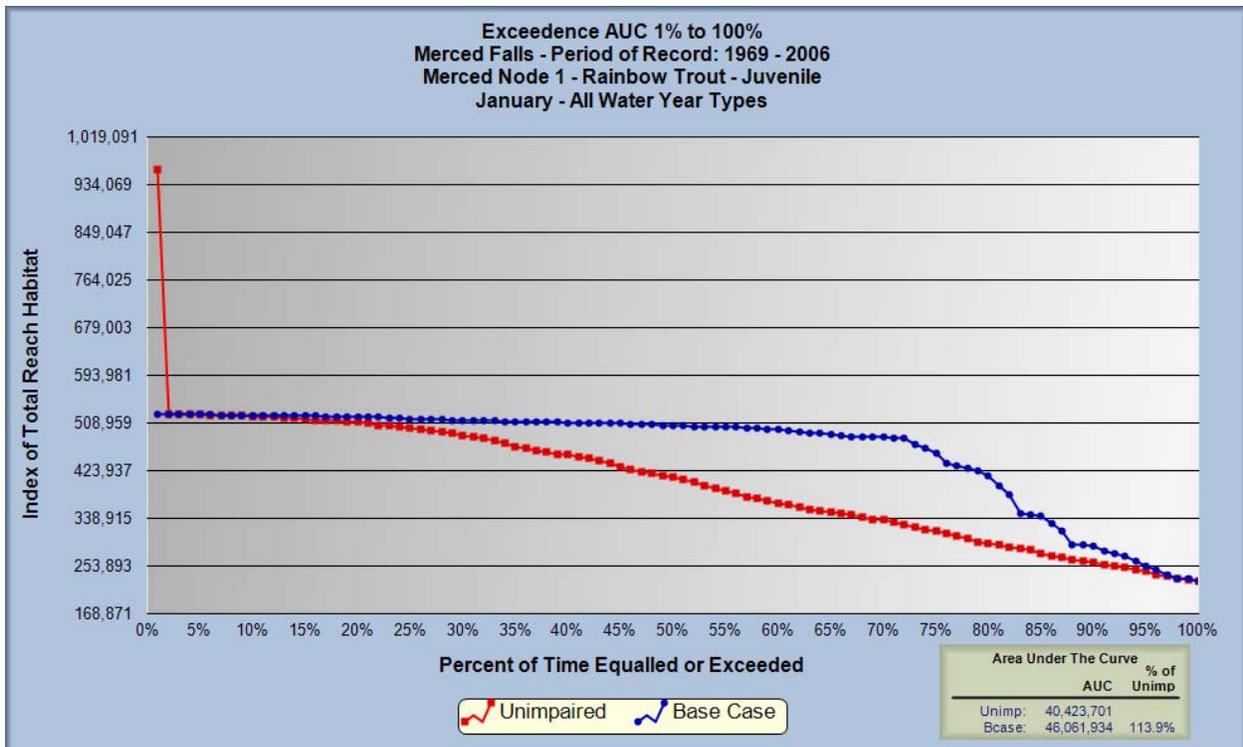


Figure 3.1-12. Habitat exceedance for rainbow trout juvenile in January.

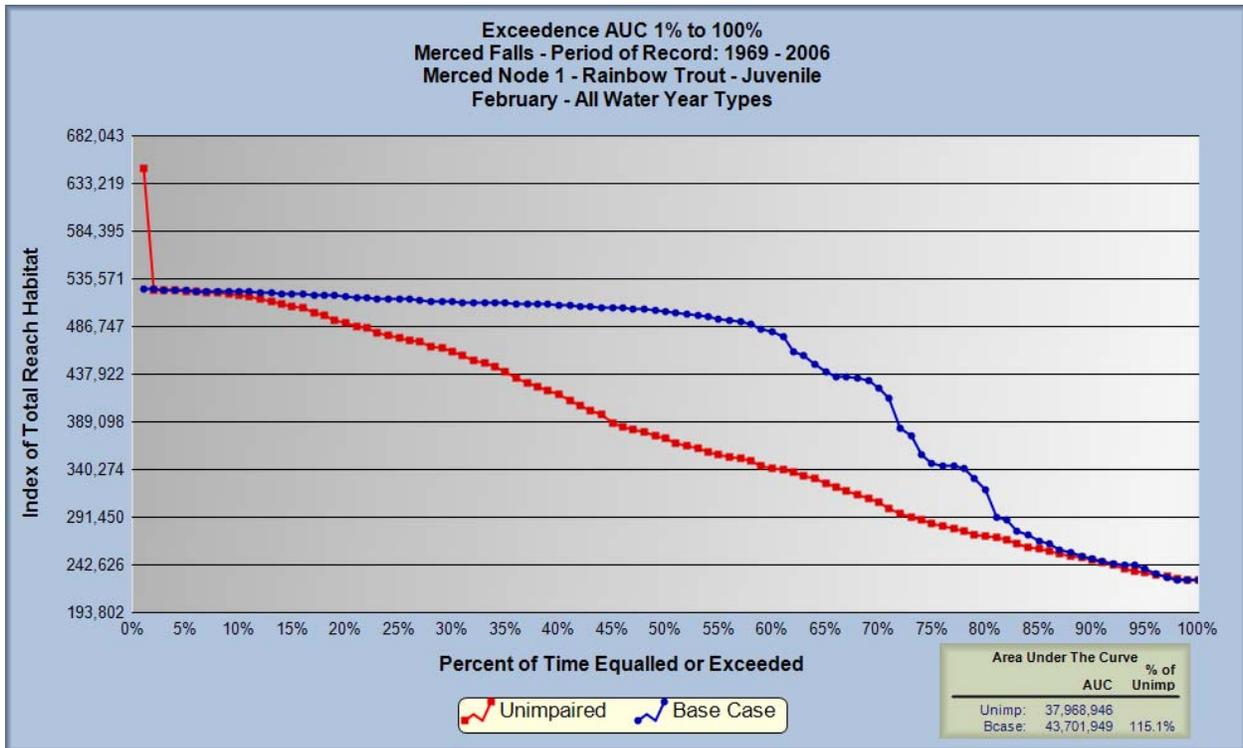


Figure 3.1-13. Habitat exceedance for rainbow trout juvenile in February.

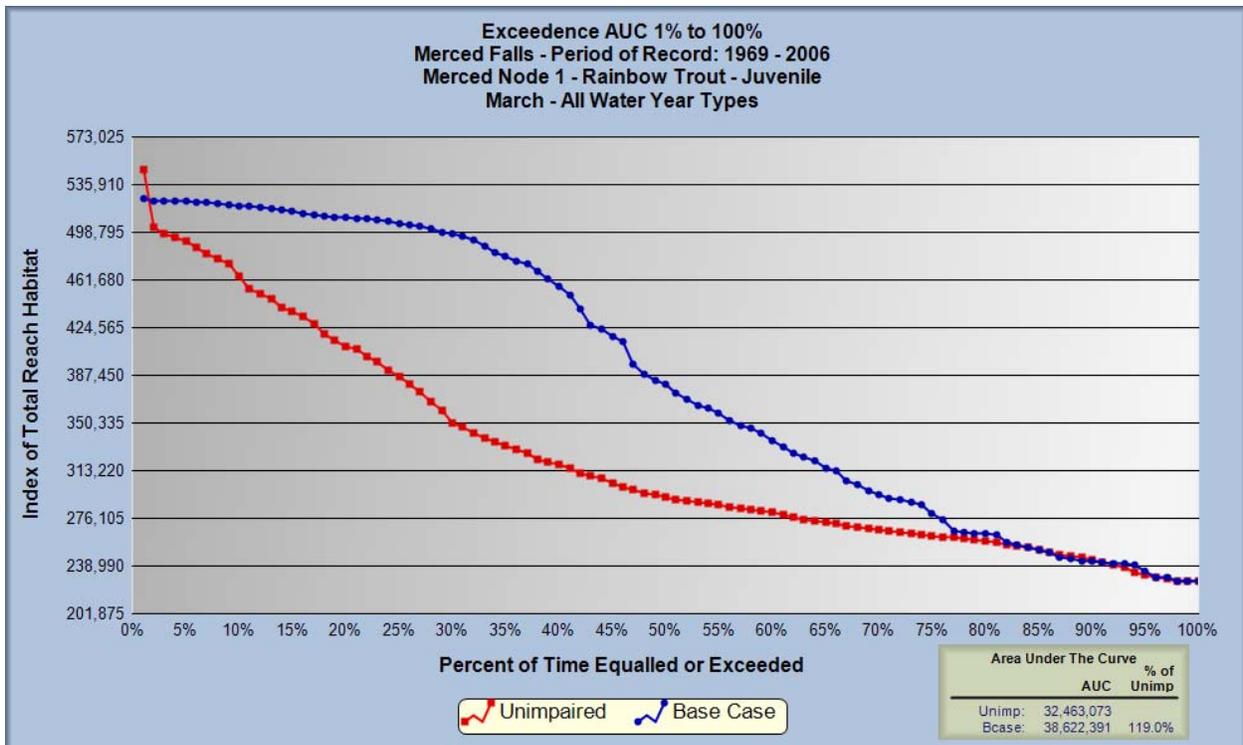


Figure 3.1-14. Habitat exceedance for rainbow trout juvenile in March.

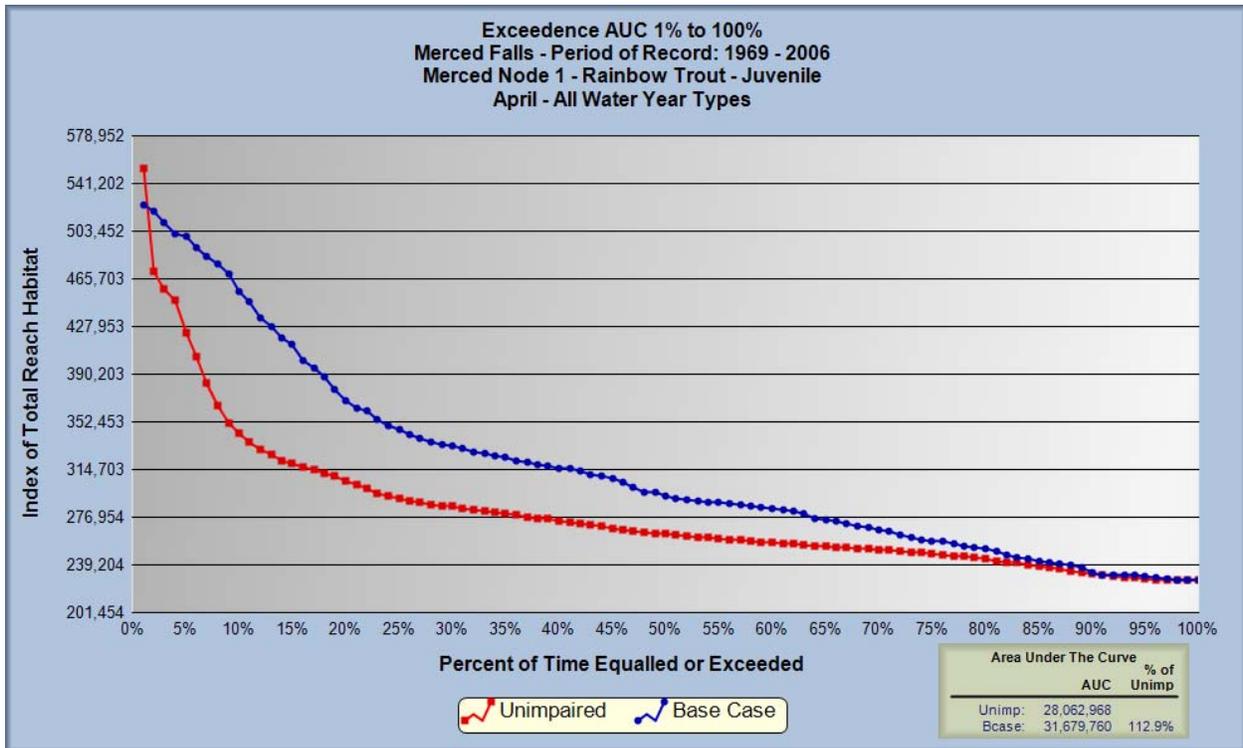


Figure 3.1-15. Habitat exceedance for rainbow trout juvenile in April.

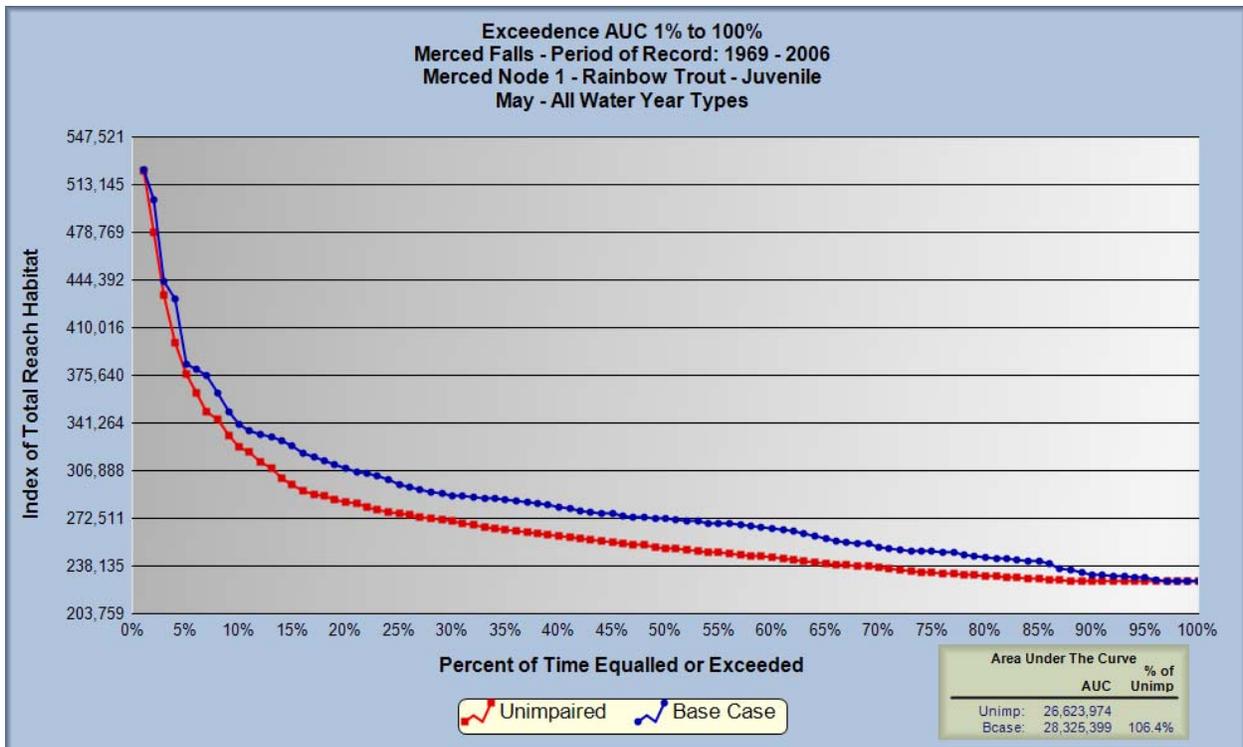


Figure 3.1-16. Habitat exceedance for rainbow trout juvenile in May.

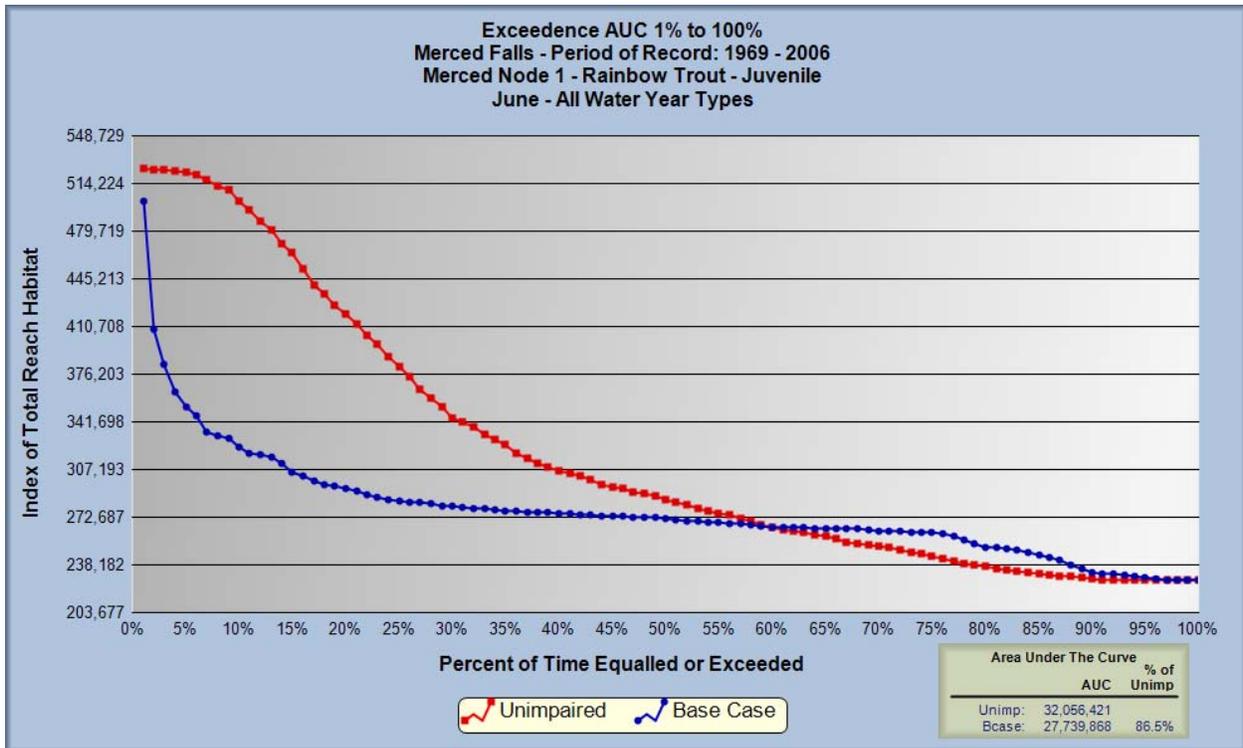


Figure 3.1-17. Habitat exceedance for rainbow trout juvenile in June.

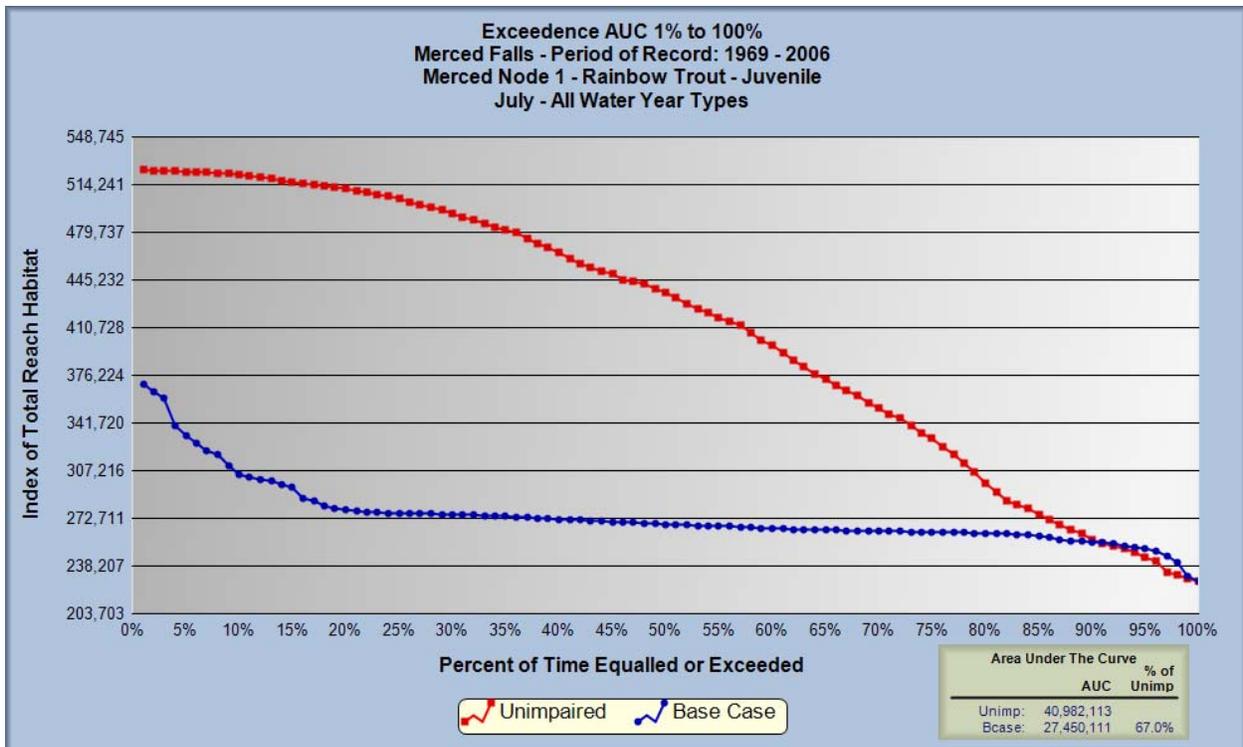


Figure 3.1-18. Habitat exceedance for rainbow trout juvenile in July.

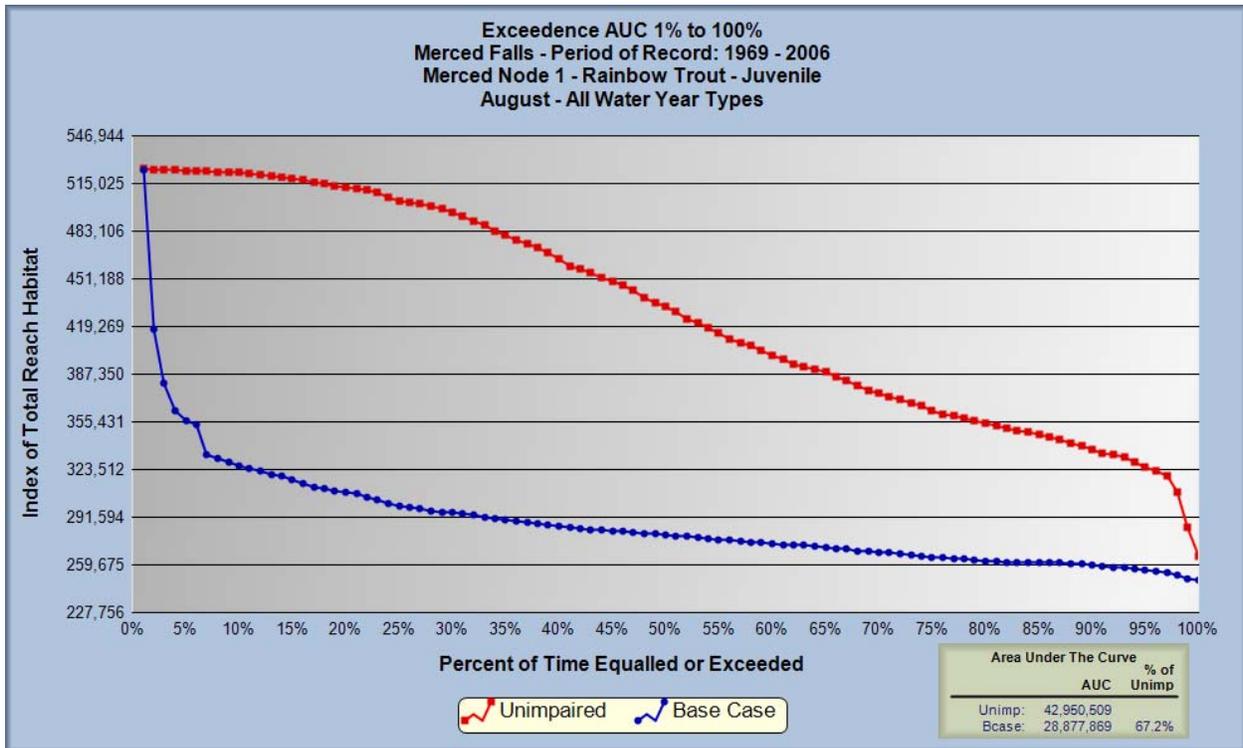


Figure 3.1-19. Habitat exceedance for rainbow trout juvenile in August.

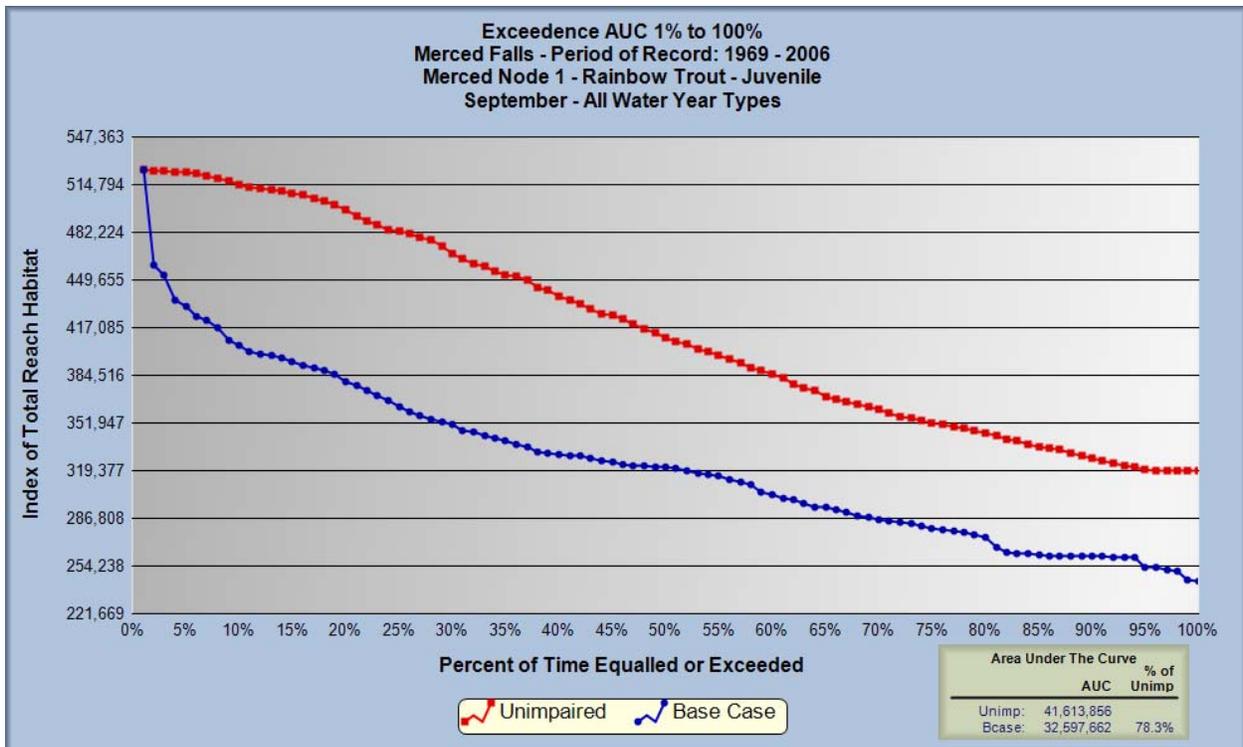


Figure 3.1-20. Habitat exceedance for rainbow trout juvenile in September.

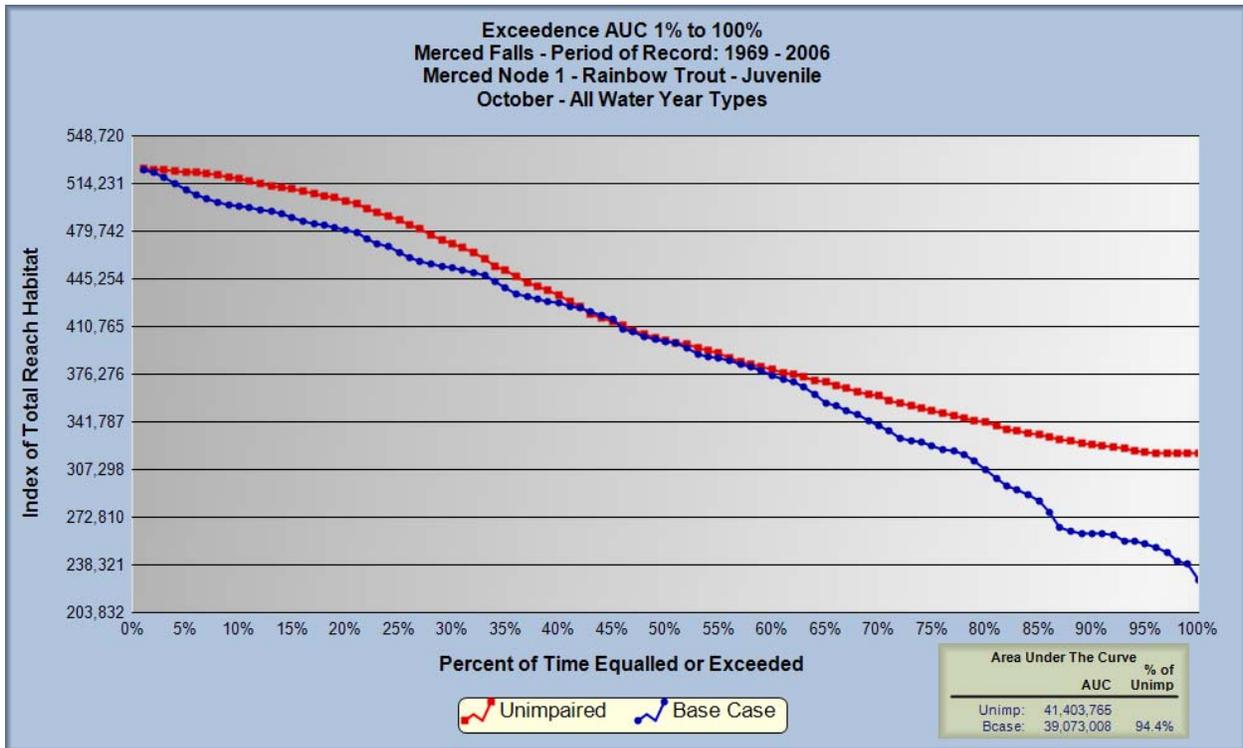


Figure 3.1-21. Habitat exceedance for rainbow trout juvenile in October.

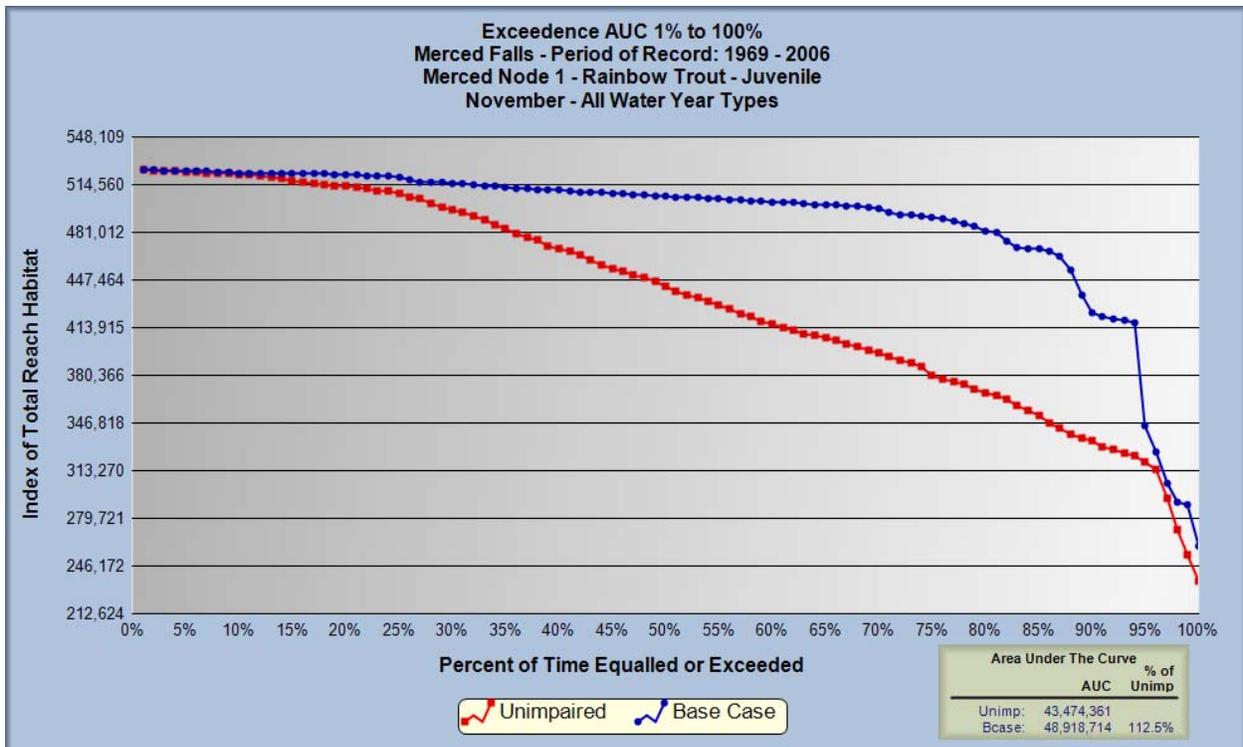


Figure 3.1-22. Habitat exceedance for rainbow trout juvenile in November.

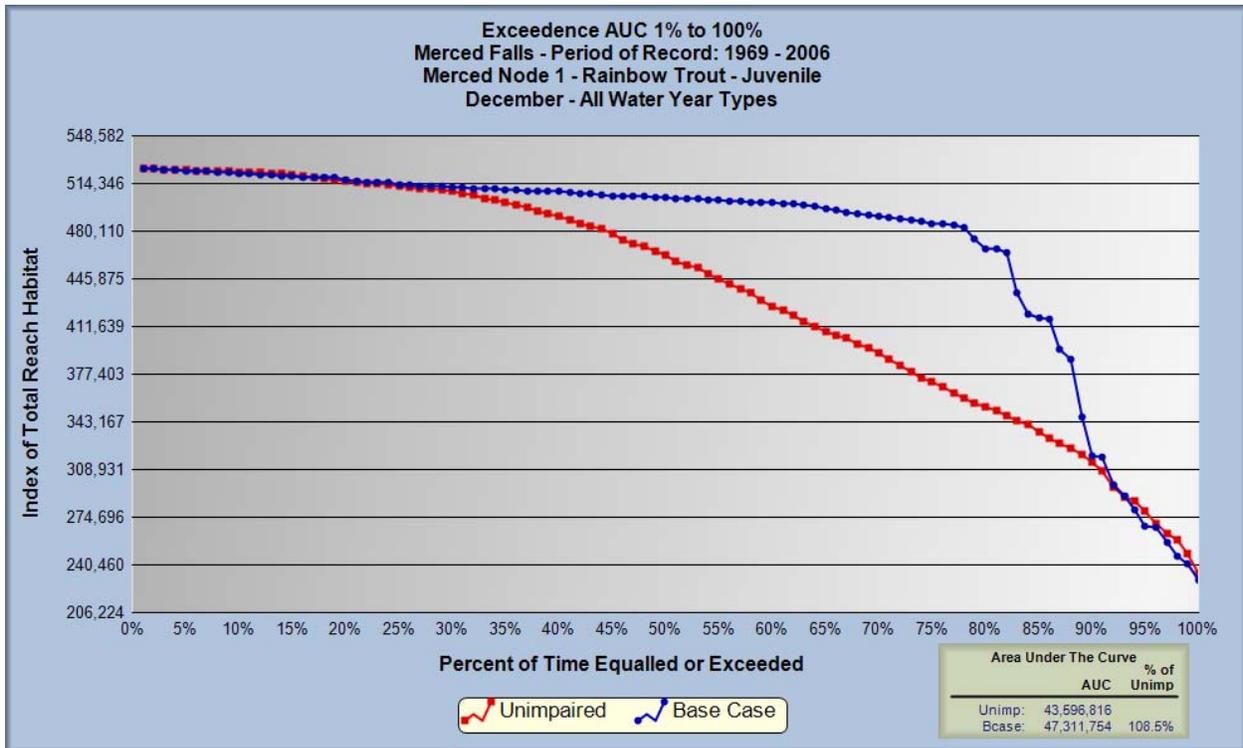


Figure 3.1-23. Habitat exceedance for rainbow trout juvenile in December.

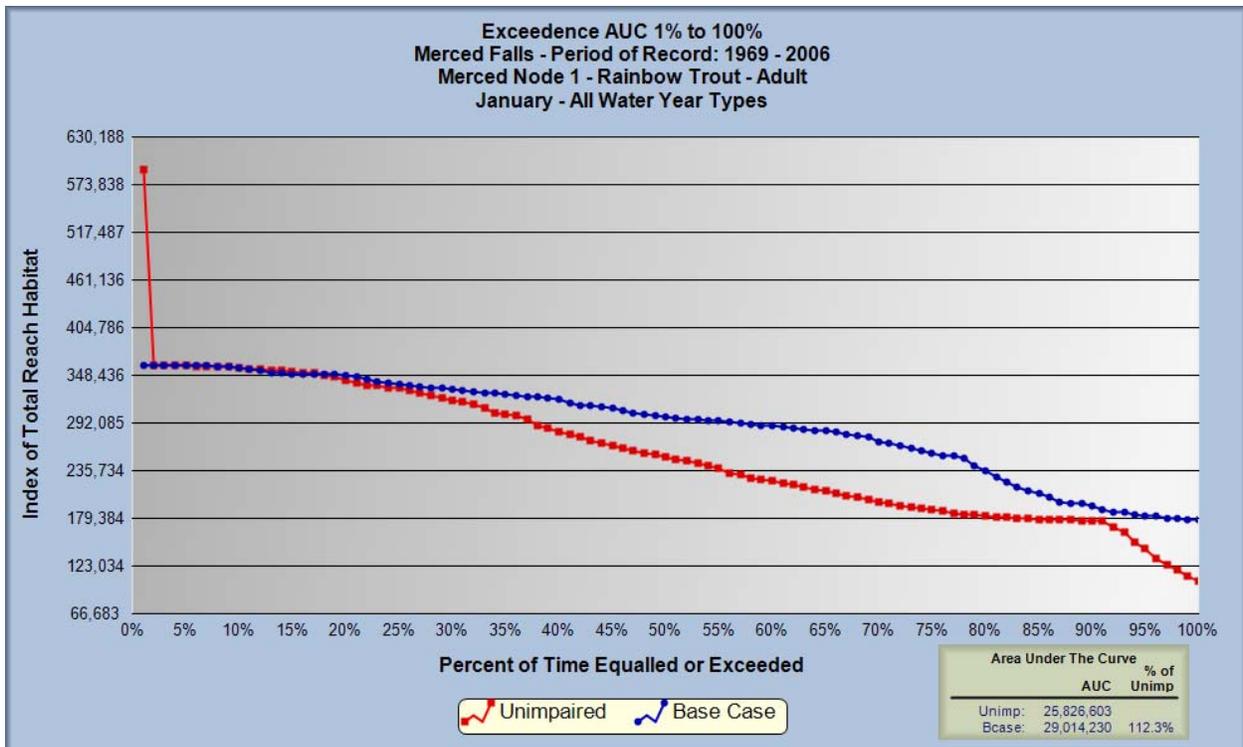


Figure 3.1-24. Habitat exceedance for rainbow trout adult in January.

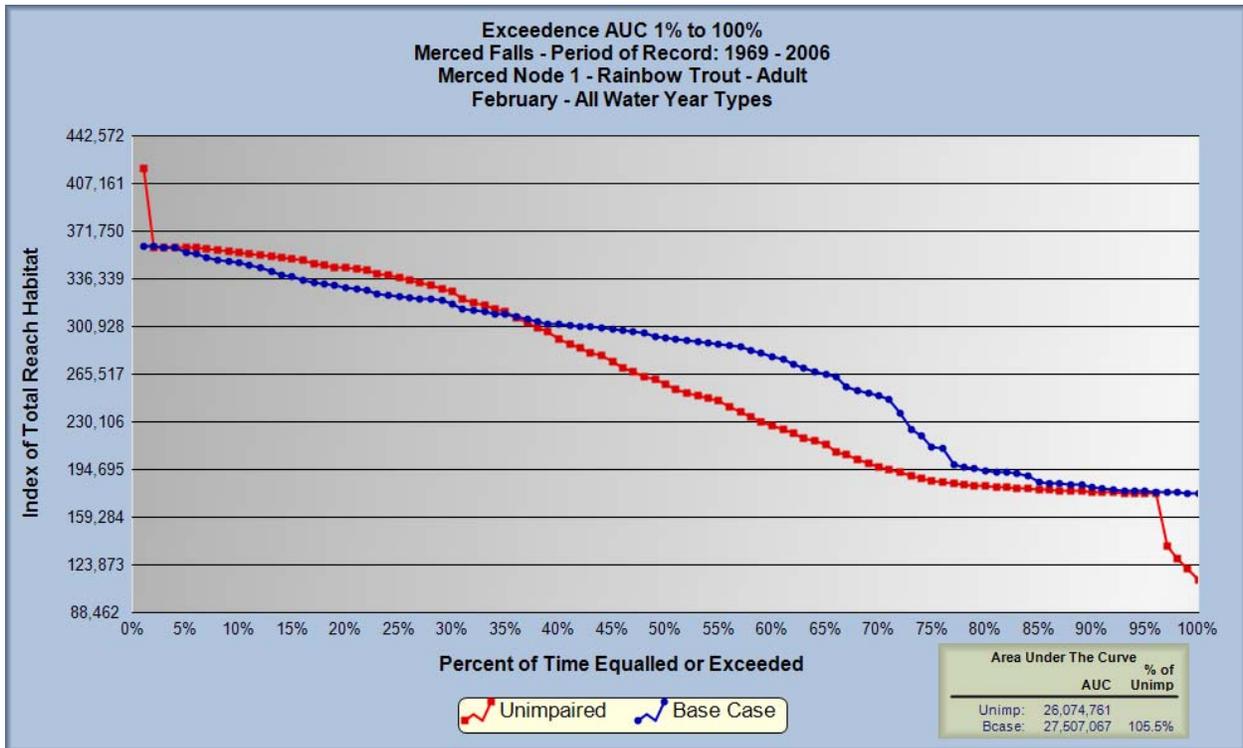


Figure 3.1-25. Habitat exceedance for rainbow trout adult in February.

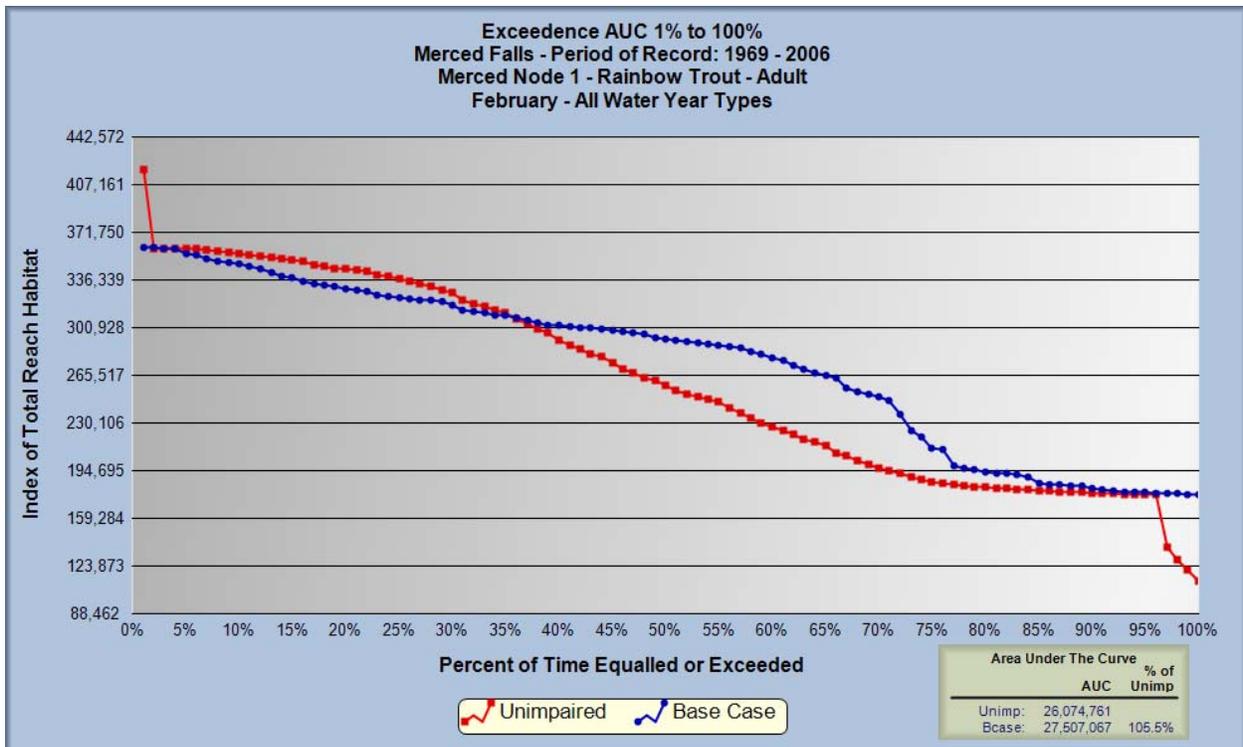


Figure 3.1-26. Habitat exceedance for rainbow trout adult in February.

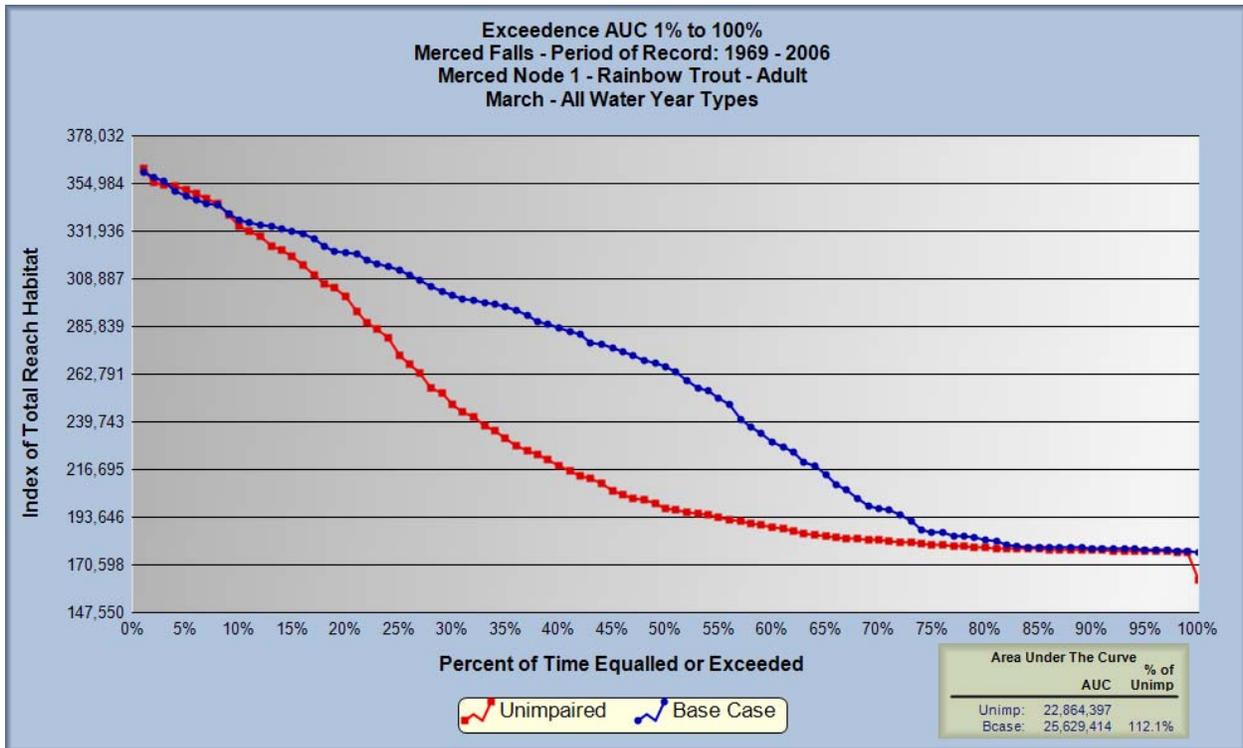


Figure 3.1-27. Habitat exceedance for rainbow trout adult in March.

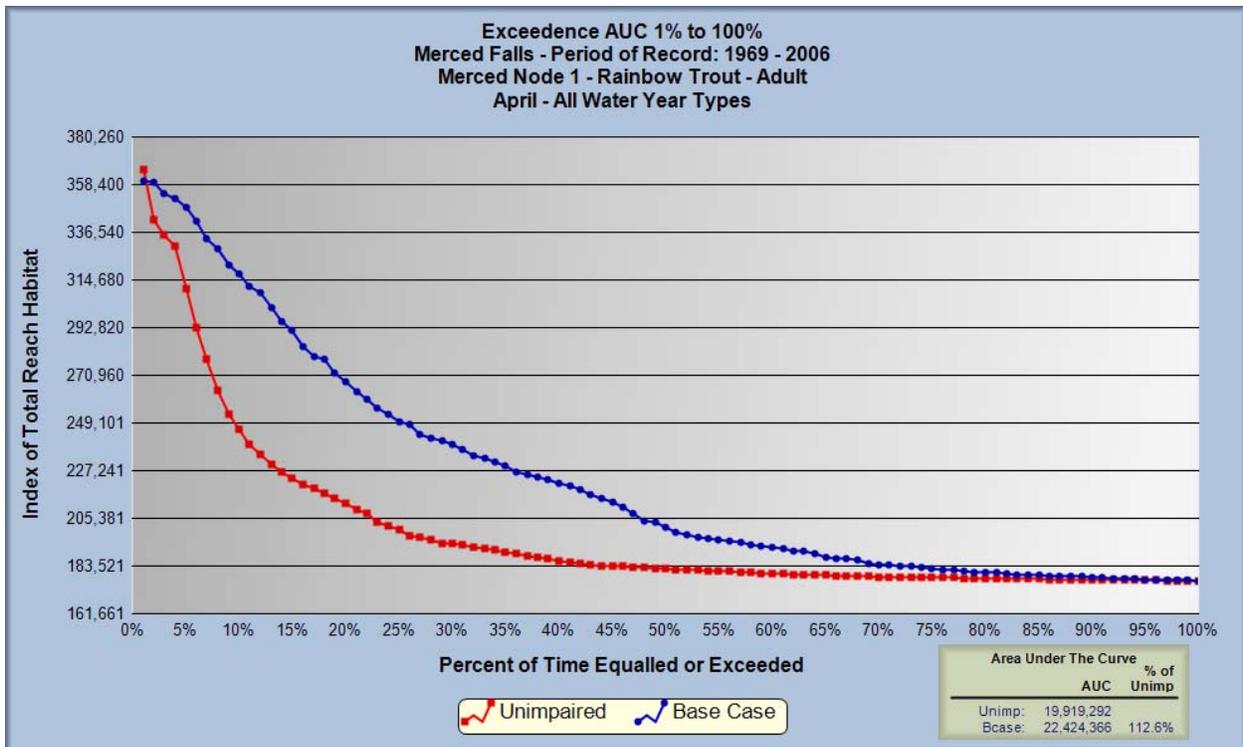


Figure 3.1-28. Habitat exceedance for rainbow trout adult in April.

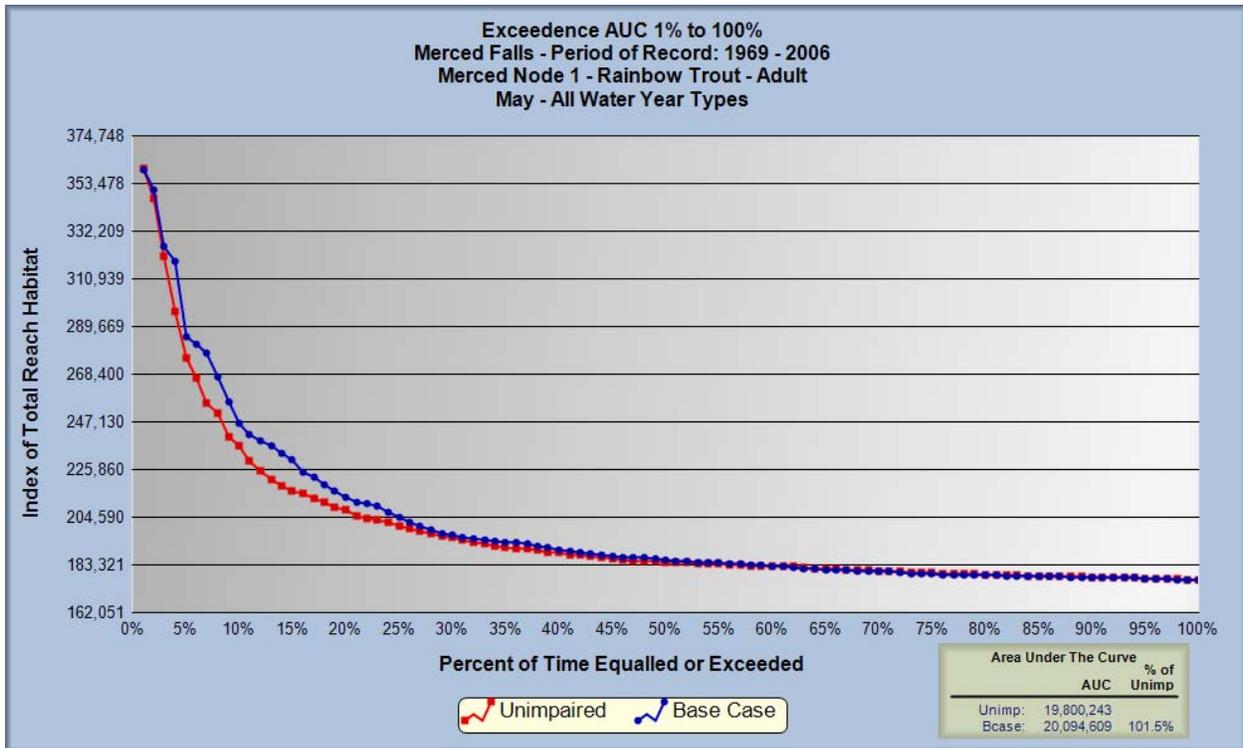


Figure 3.1-29. Habitat exceedance for rainbow trout adult in May.

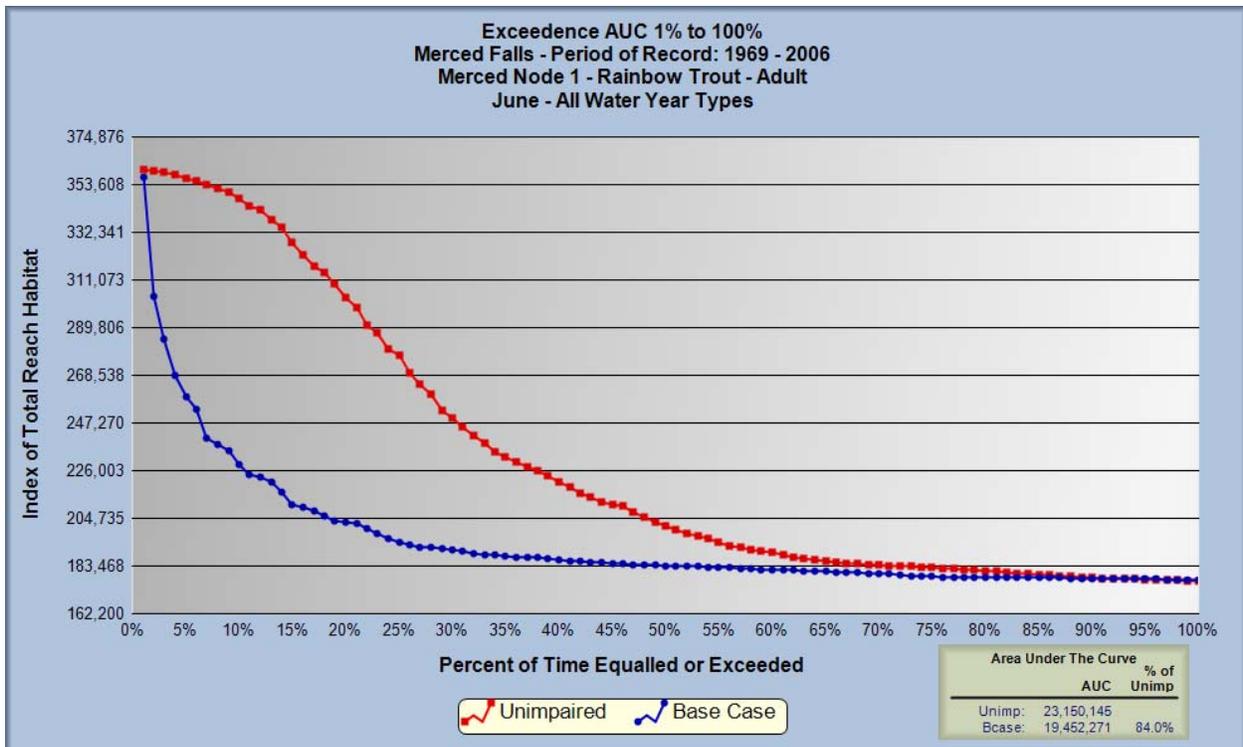


Figure 3.1-30. Habitat exceedance for rainbow trout adult in June.

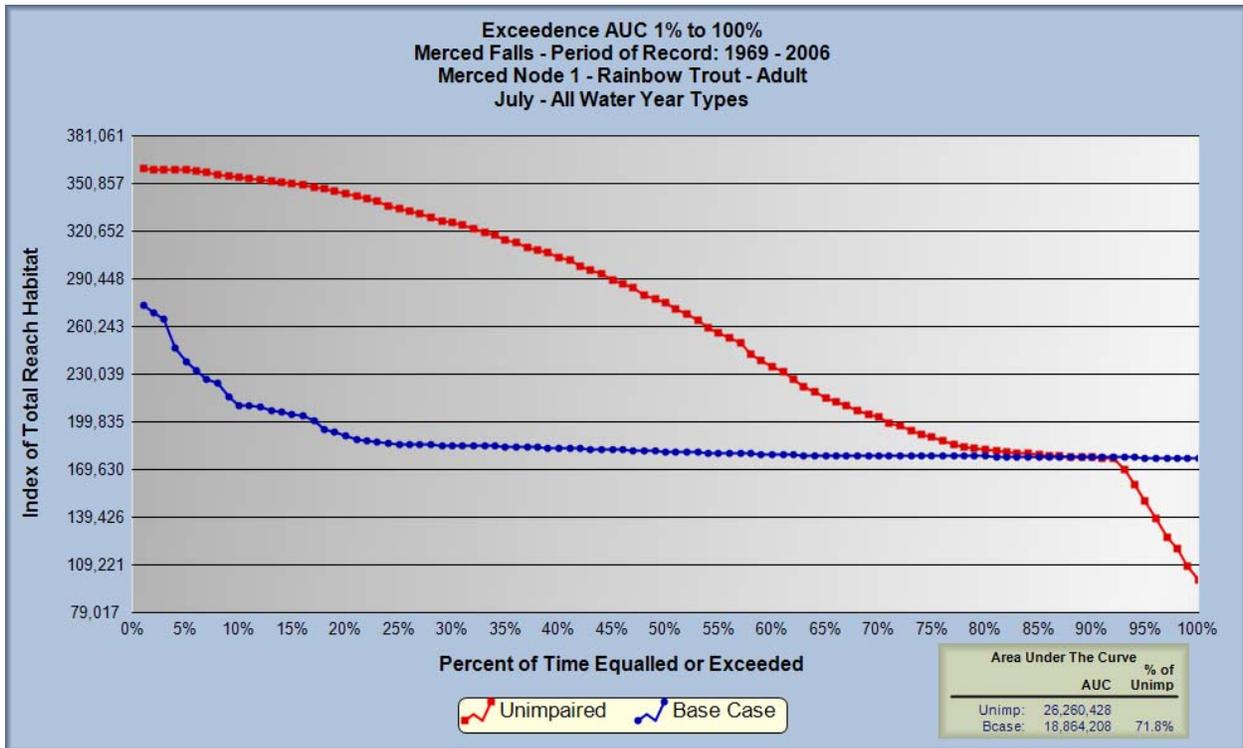


Figure 3.1-31. Habitat exceedance for rainbow trout adult in July.

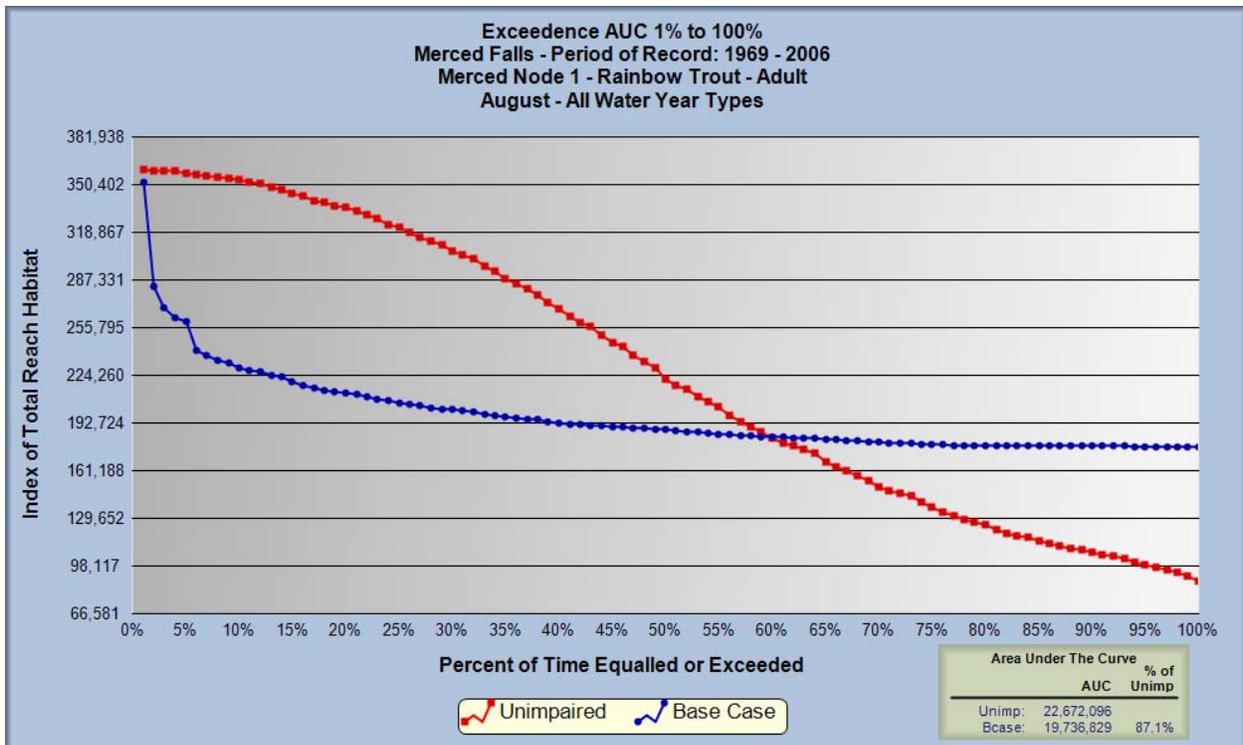


Figure 3.1-32. Habitat exceedance for rainbow trout adult in August.

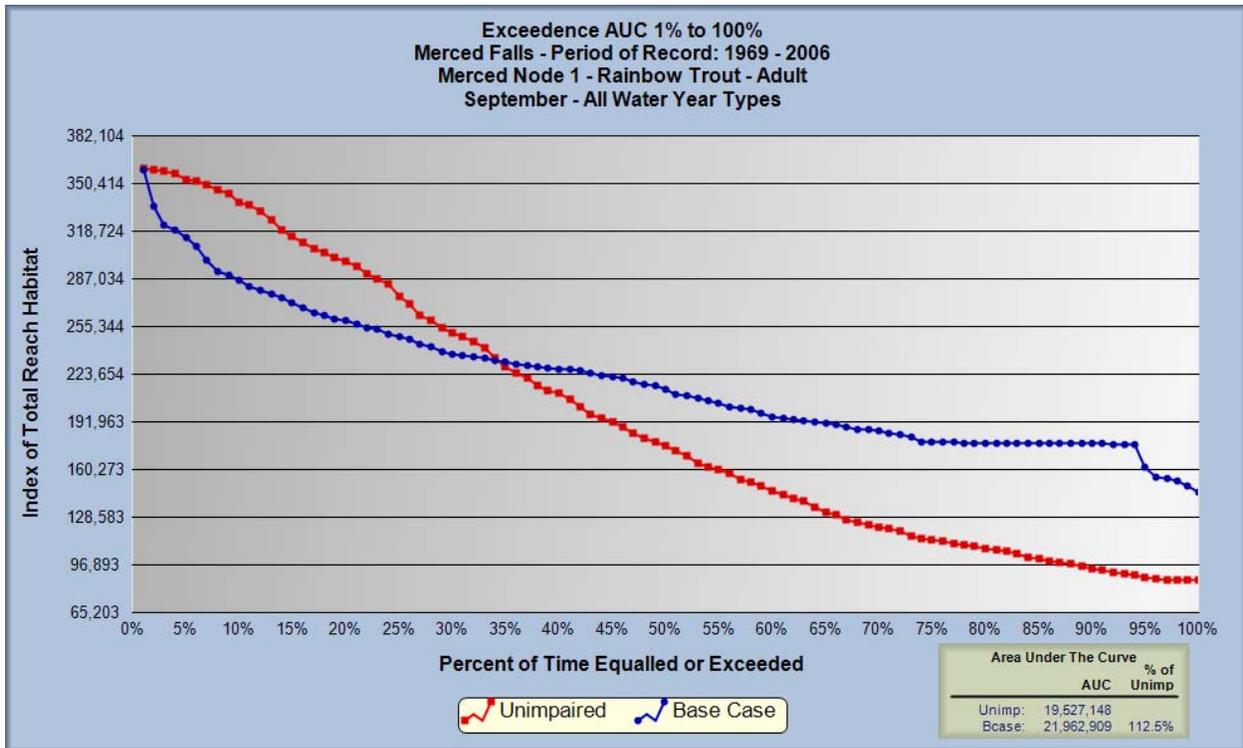


Figure 3.1-33. Habitat exceedance for rainbow trout adult in September.

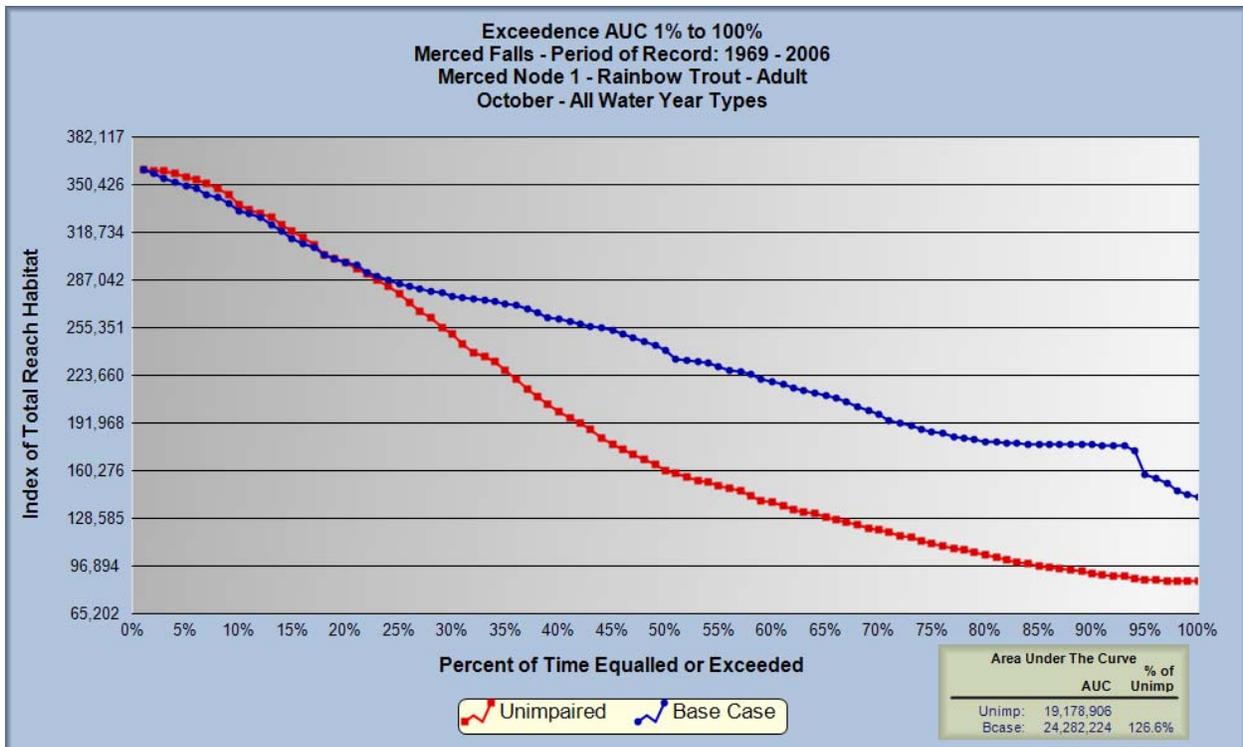


Figure 3.1-34. Habitat exceedance for rainbow trout adult in October.

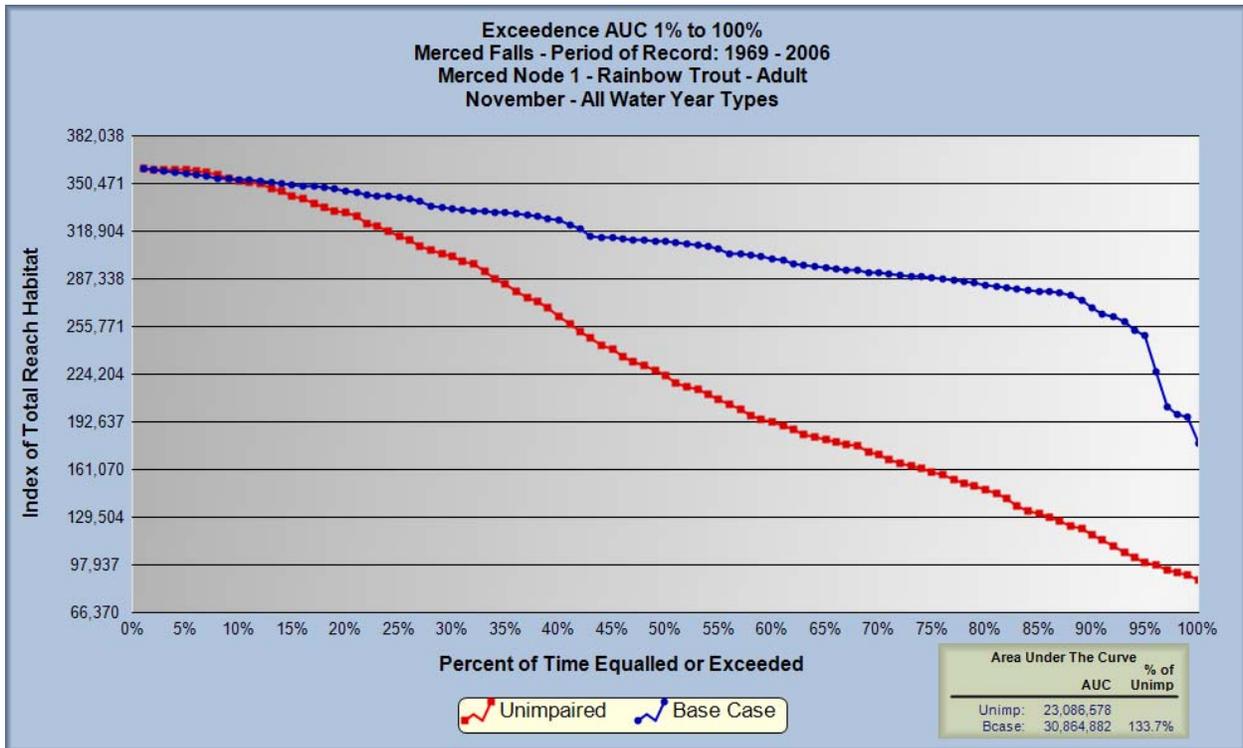


Figure 3.1-35. Habitat exceedance for rainbow trout adult in November.

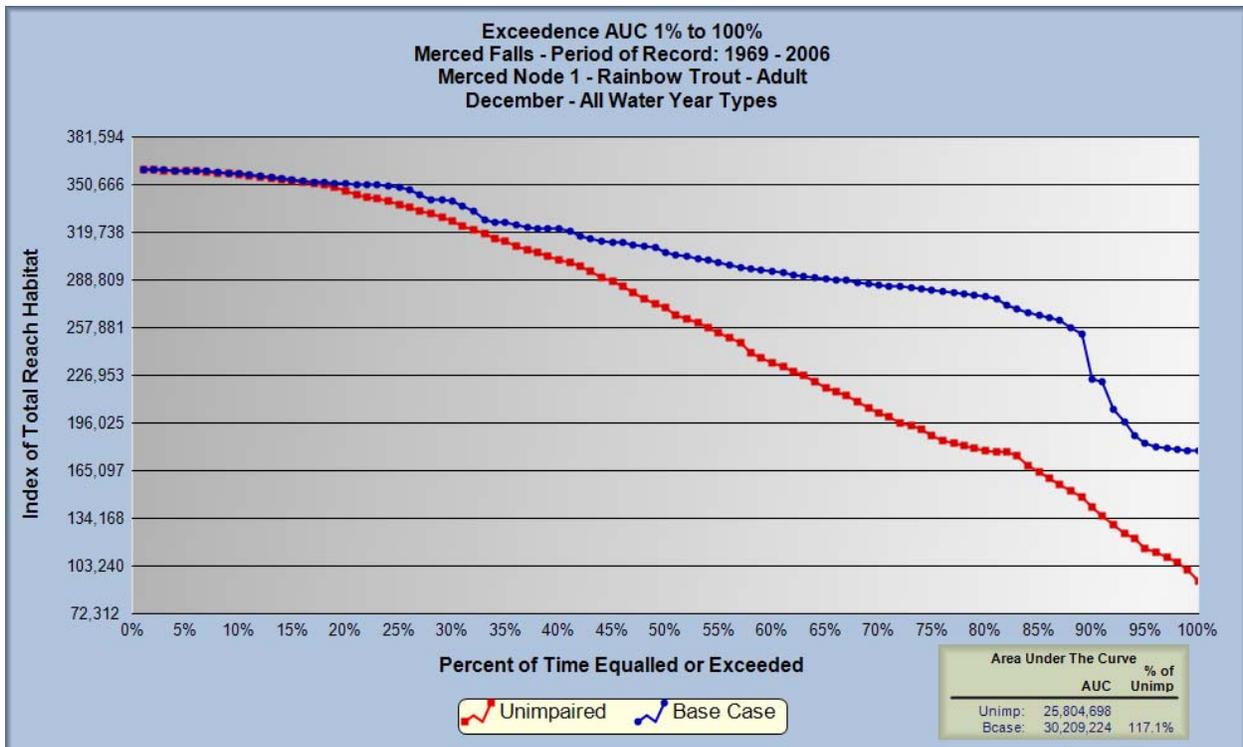


Figure 3.1-36. Habitat exceedance for rainbow trout adult in December.

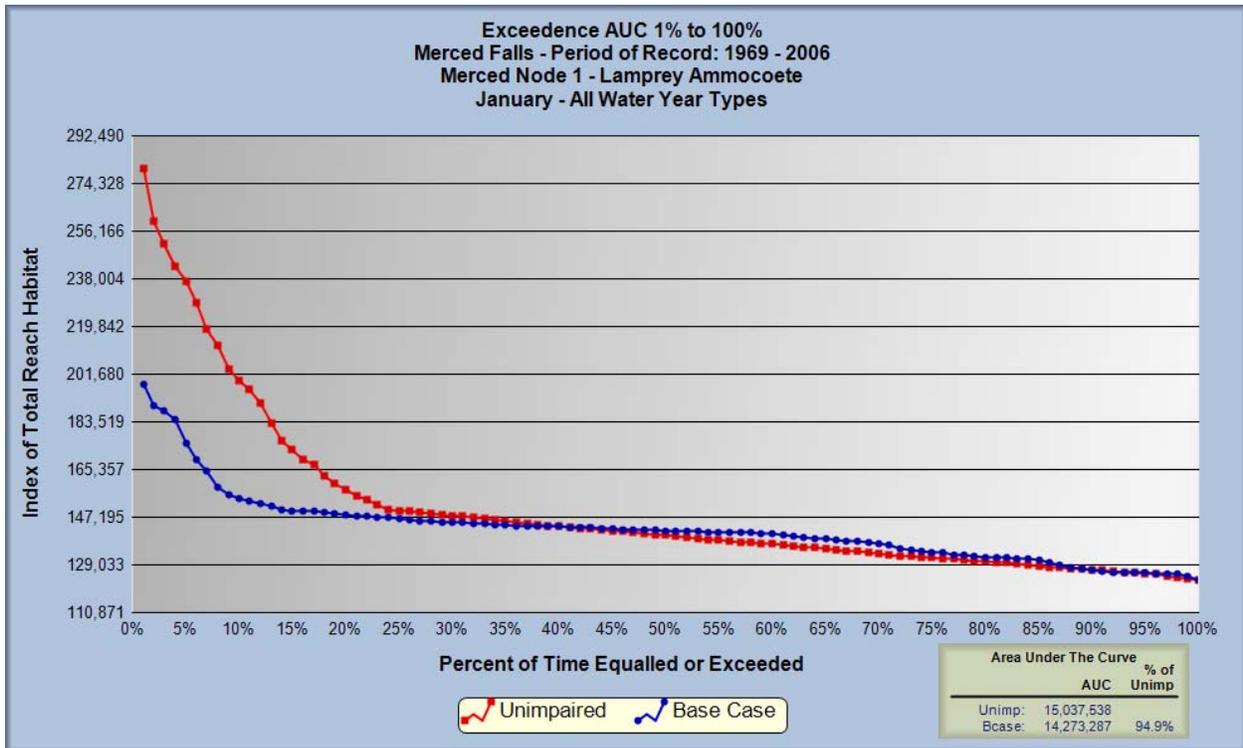


Figure 3.1-37. Habitat exceedance for lamprey ammocoete in January.

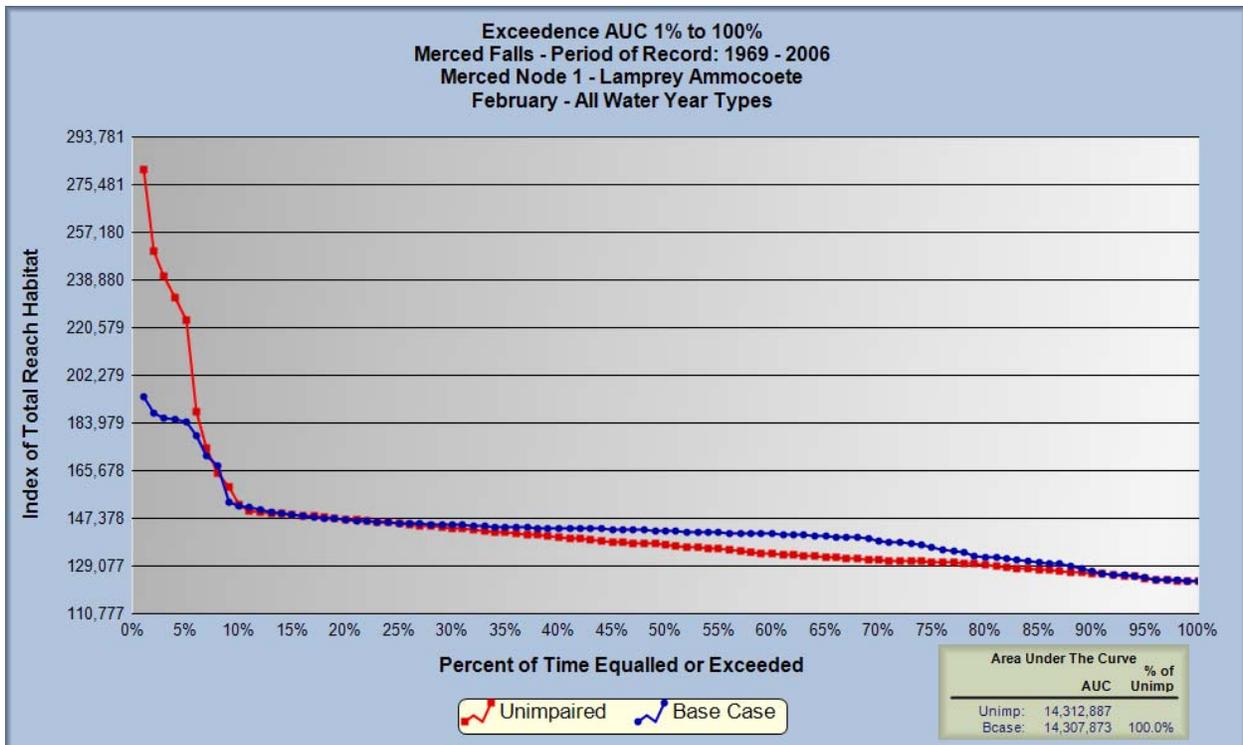


Figure 3.1-38. Habitat exceedance for lamprey ammocoete in February.

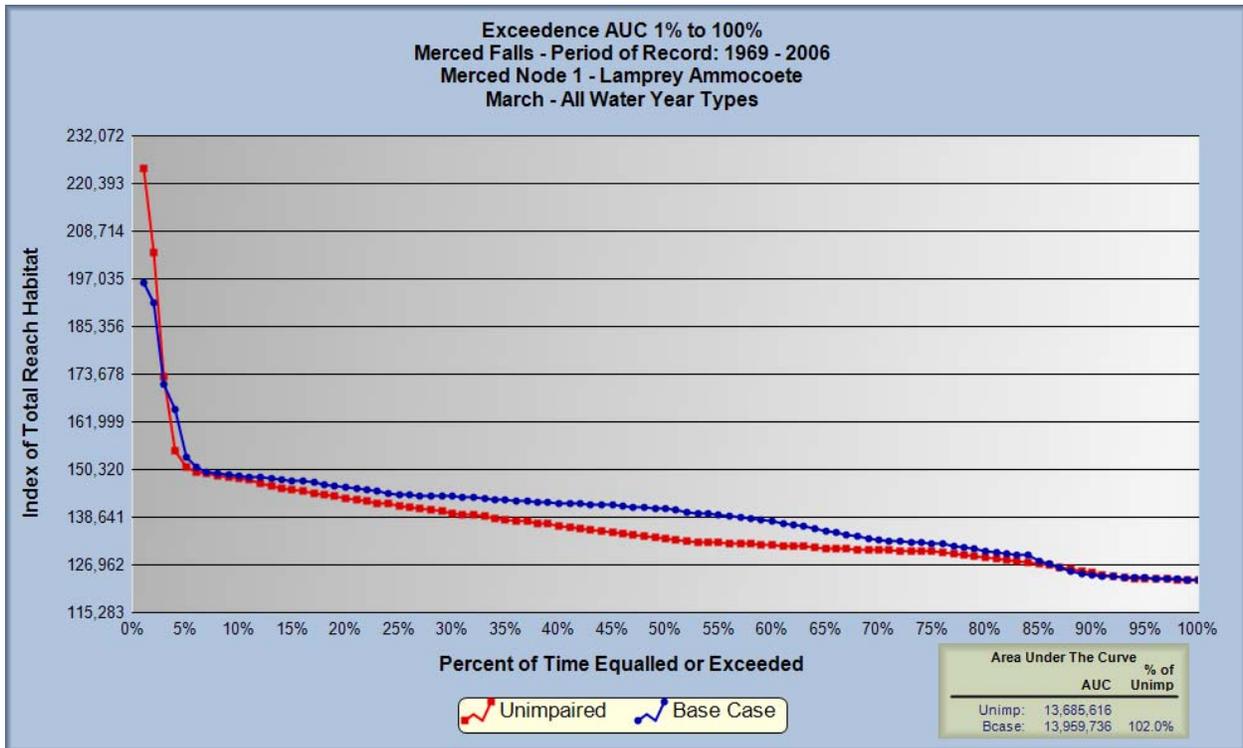


Figure 3.1-39. Habitat exceedance for lamprey ammocoete in March.

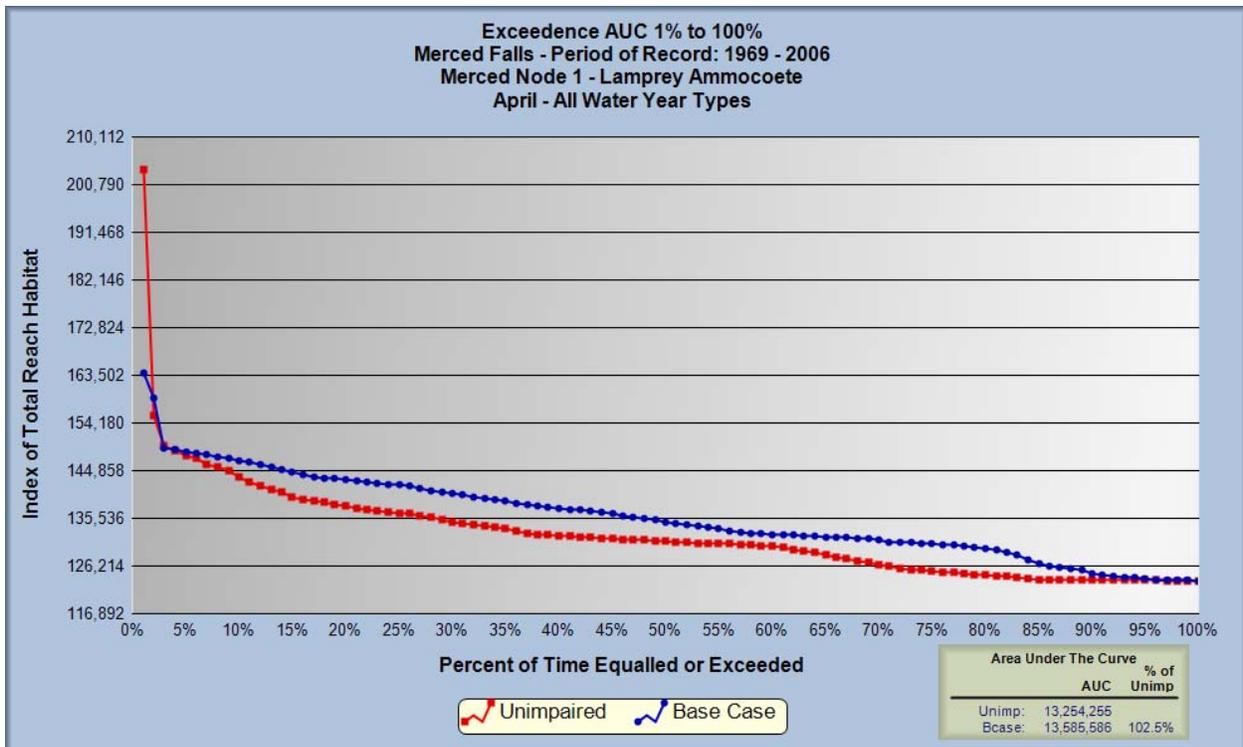


Figure 3.1-40. Habitat exceedance for lamprey ammocoete in April.

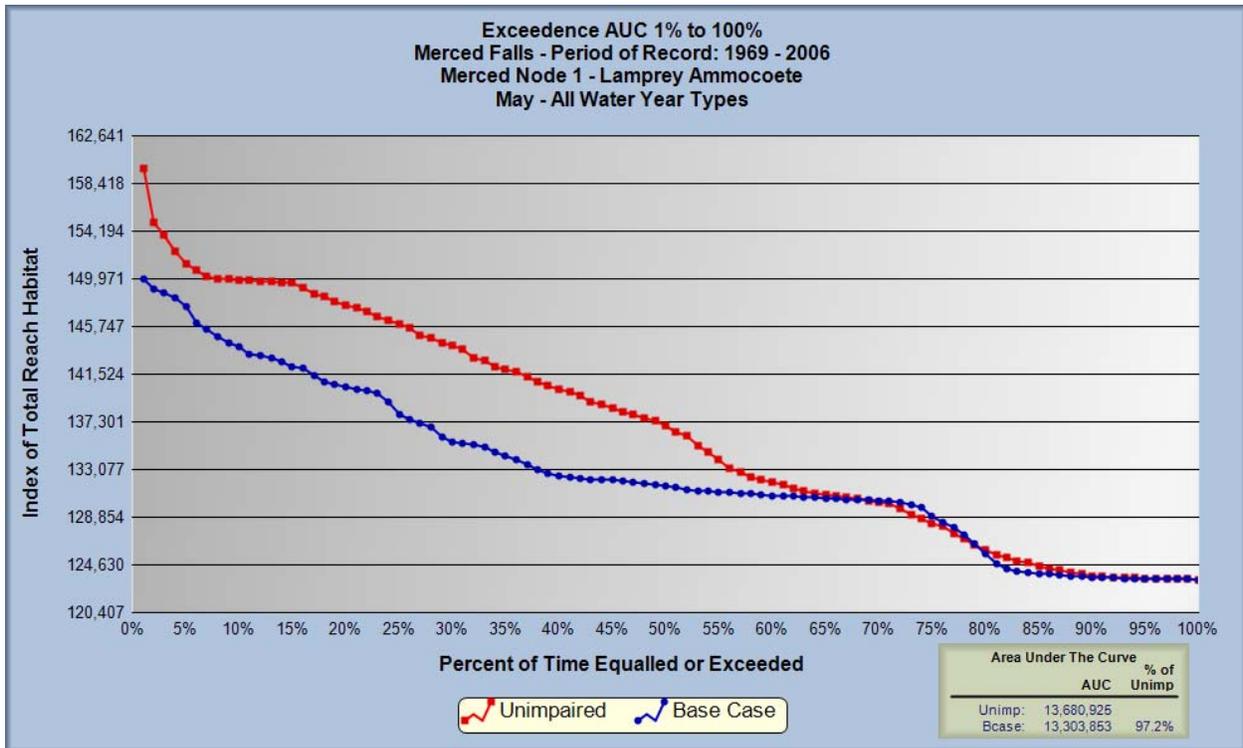


Figure 3.1-41. Habitat exceedance for lamprey ammocoete in May.

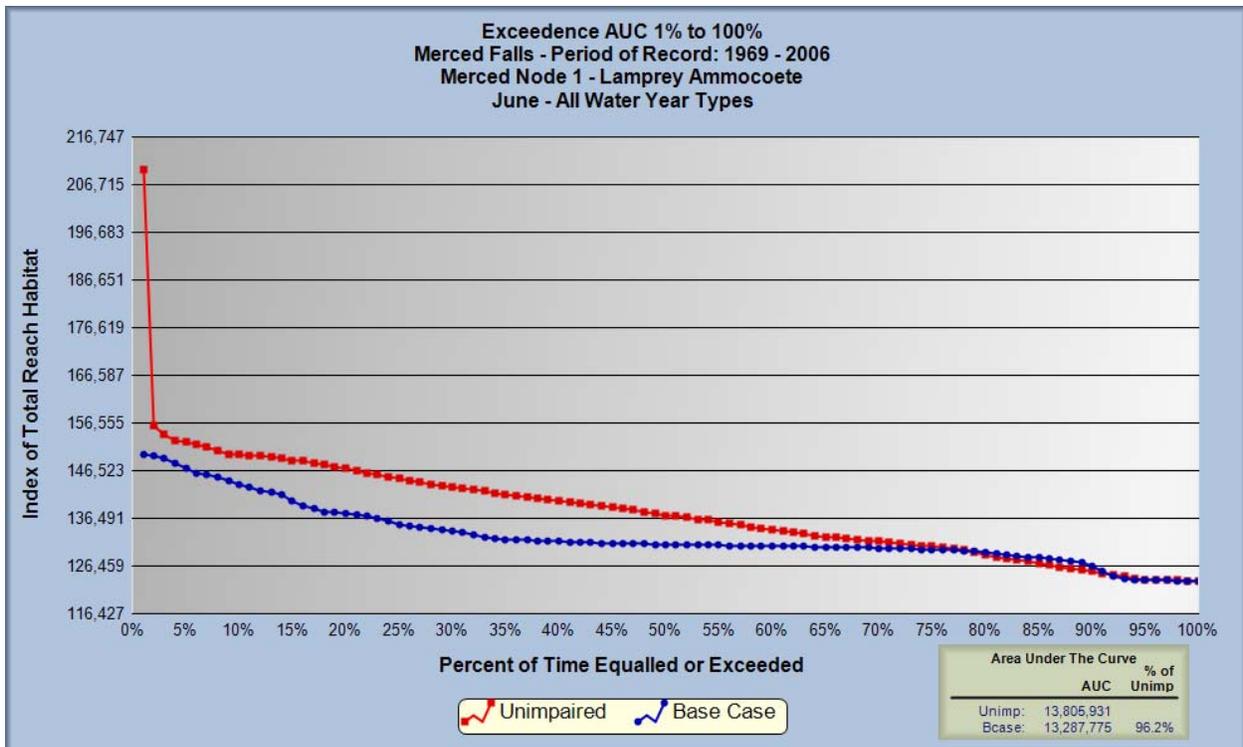


Figure 3.1-42. Habitat exceedance for lamprey ammocoete in June.

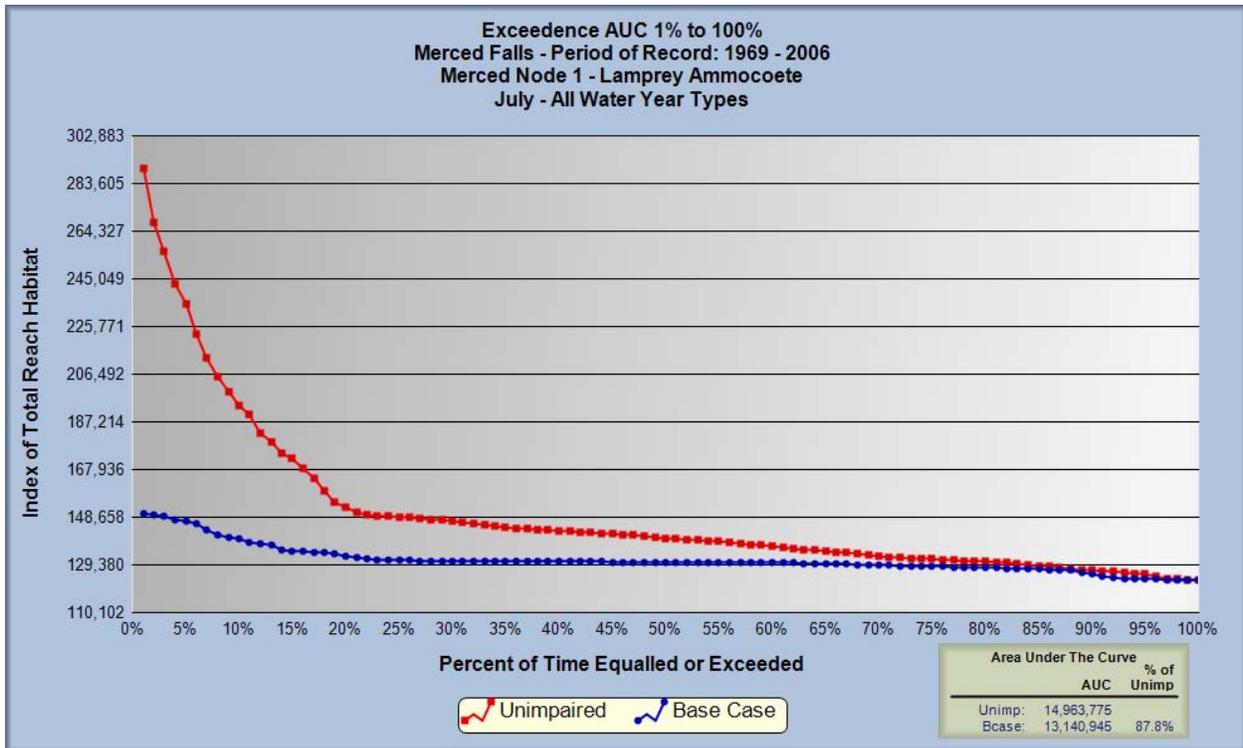


Figure 3.1-43. Habitat exceedance for lamprey ammocoete in July.

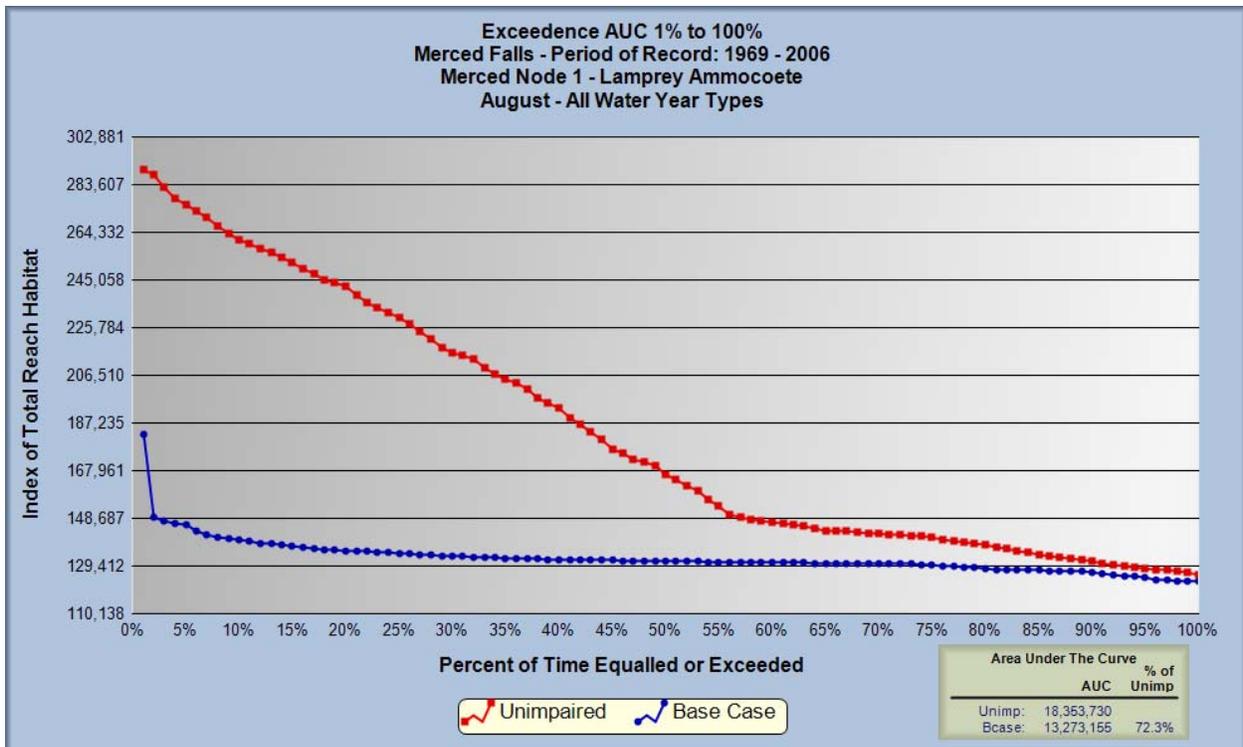


Figure 3.1-44. Habitat exceedance for lamprey ammocoete in August.

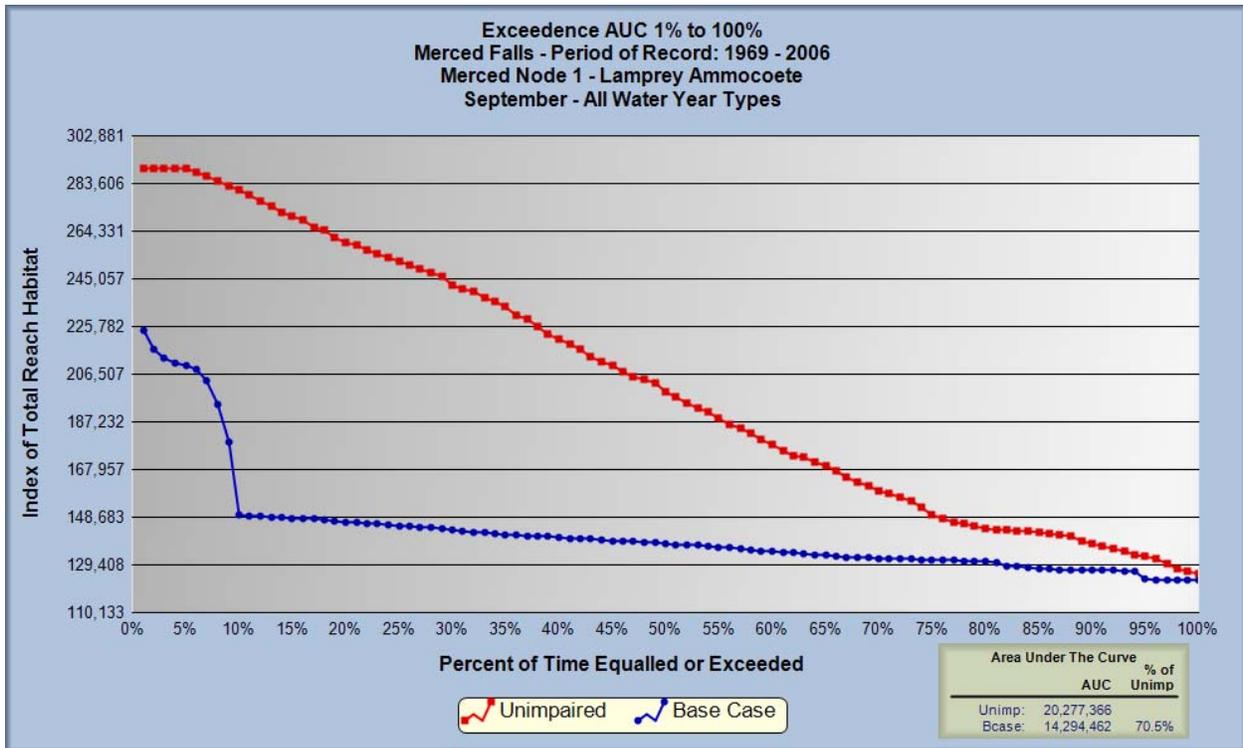


Figure 3.1-45. Habitat exceedance for lamprey ammocoete in September.

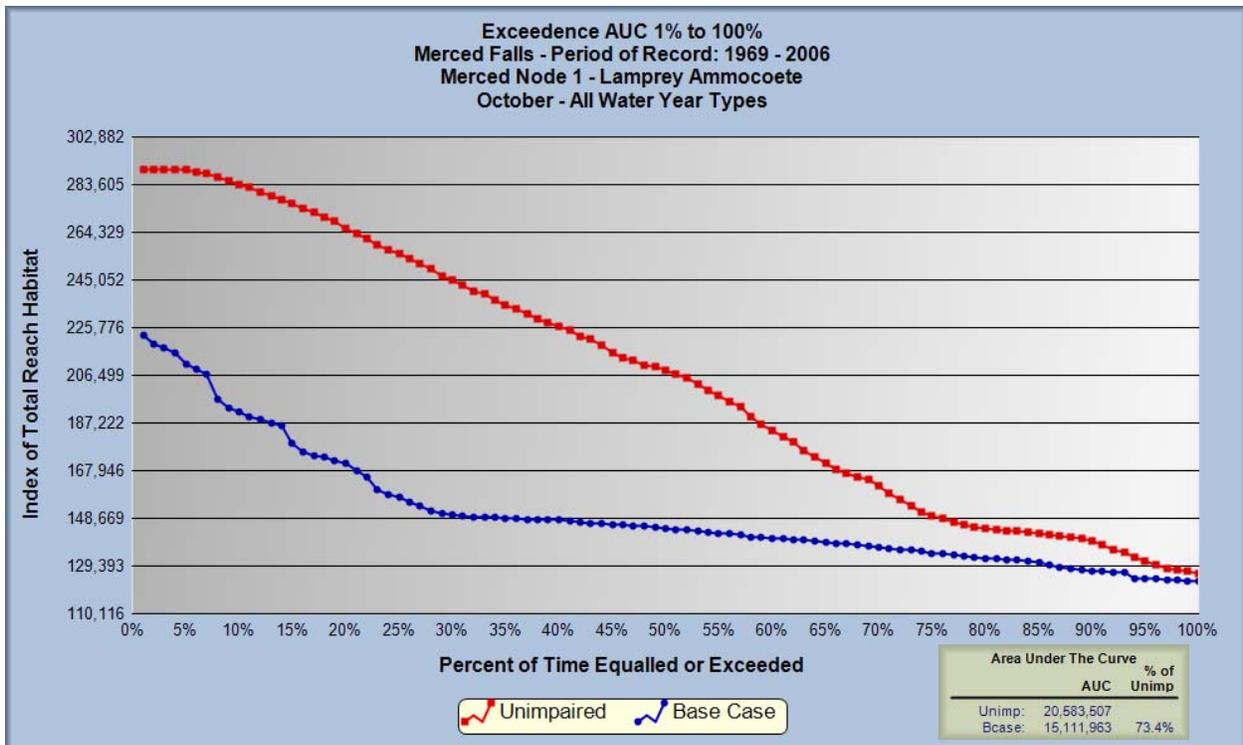


Figure 3.1-46. Habitat exceedance for lamprey ammocoete in October.

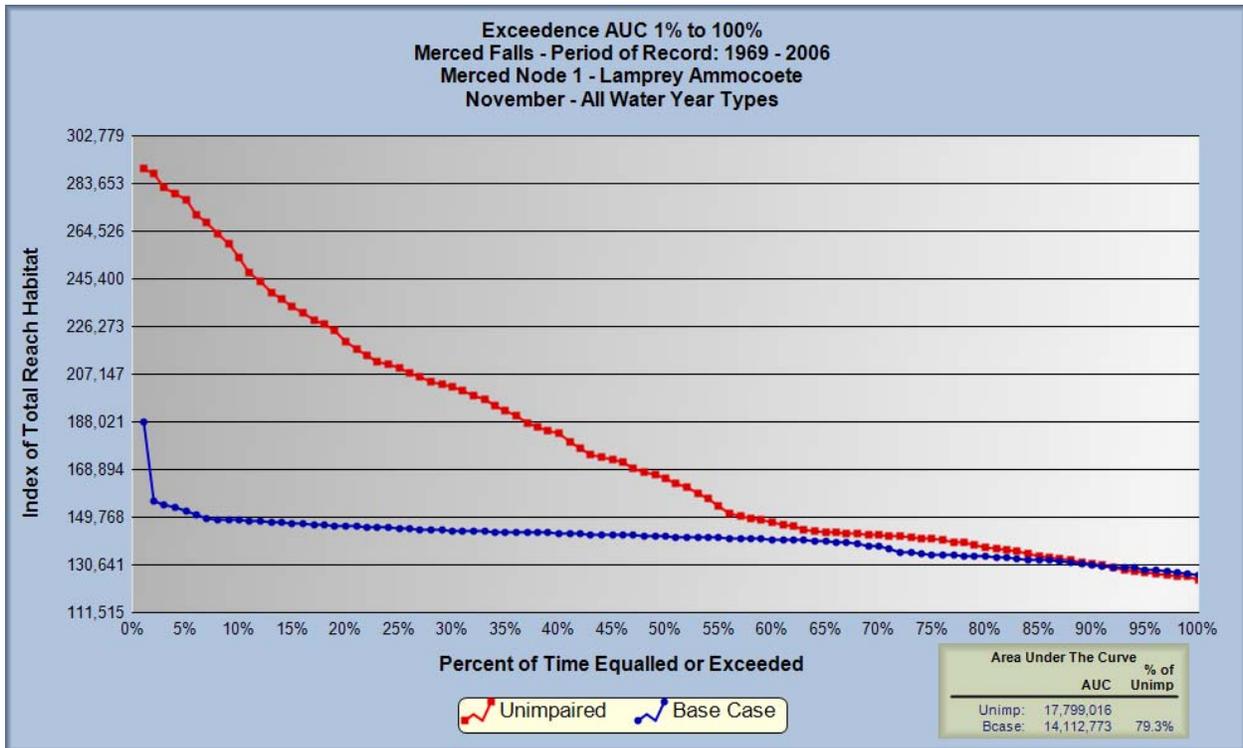


Figure 3.1-47. Habitat exceedance for lamprey ammocoete in November.

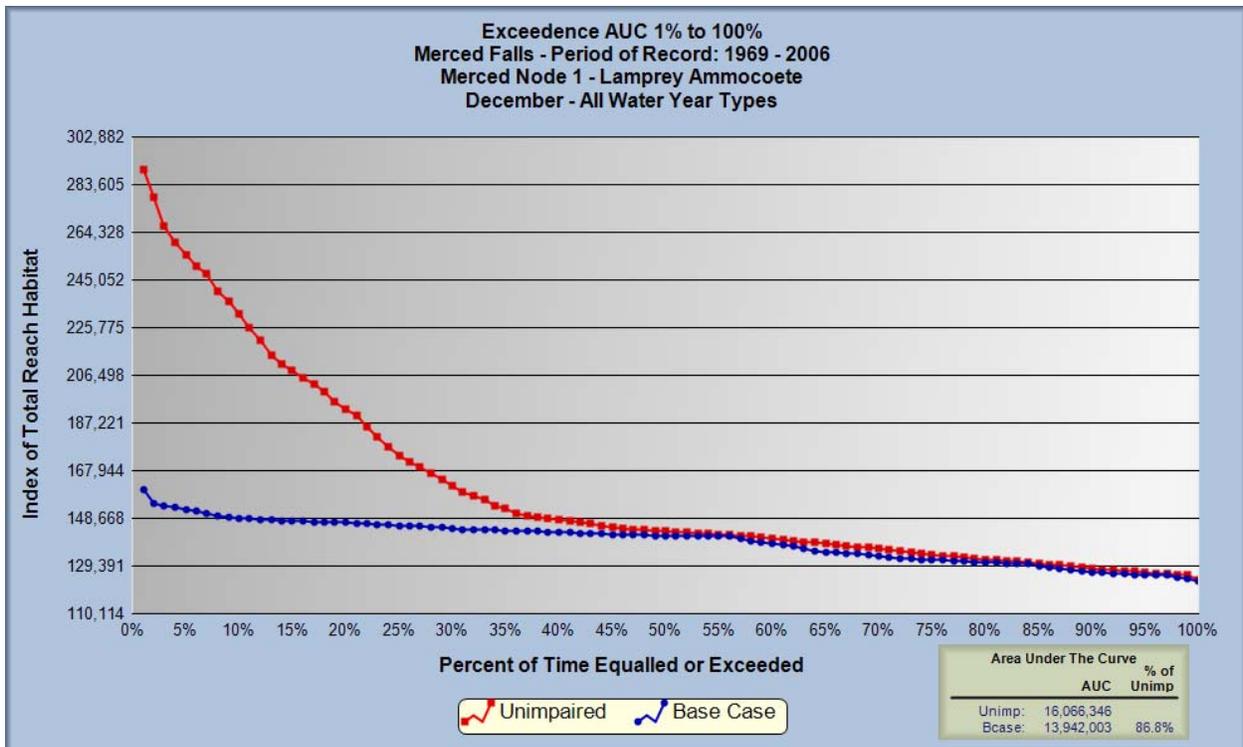


Figure 3.1-48. Habitat exceedance for lamprey ammocoete in December.

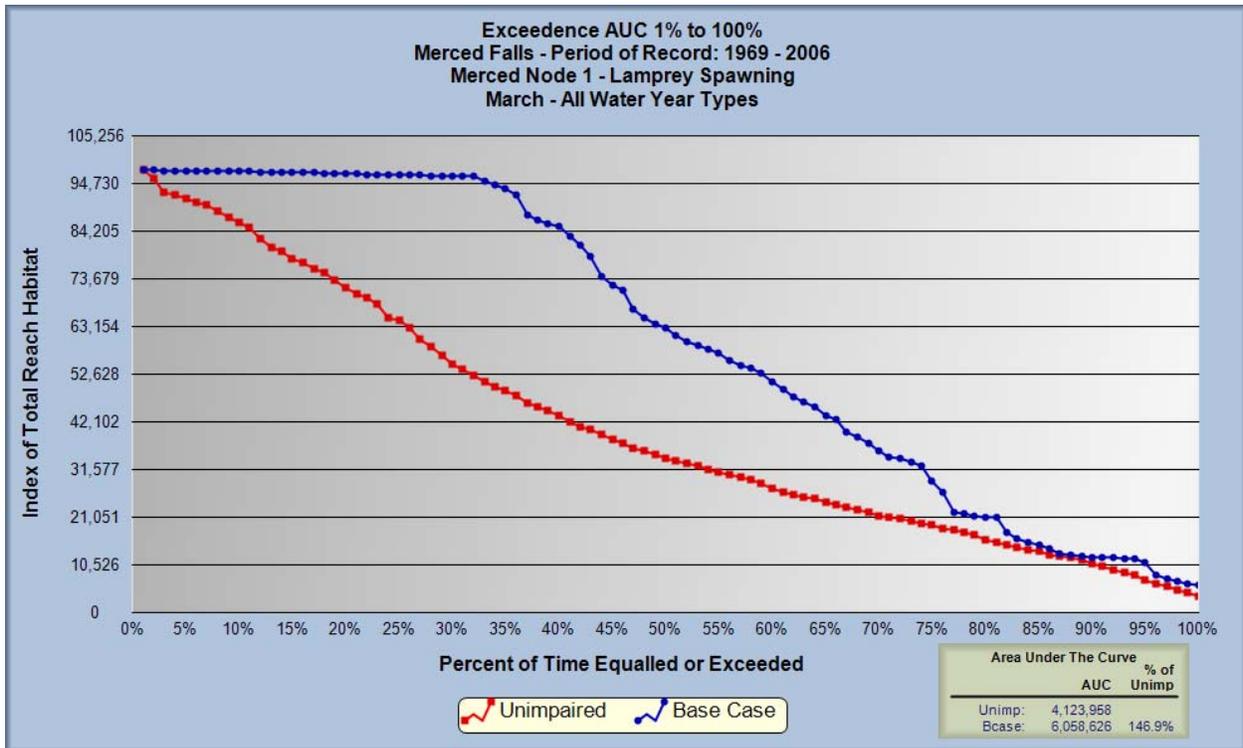


Figure 3.1-49. Habitat exceedance for lamprey spawning in March.

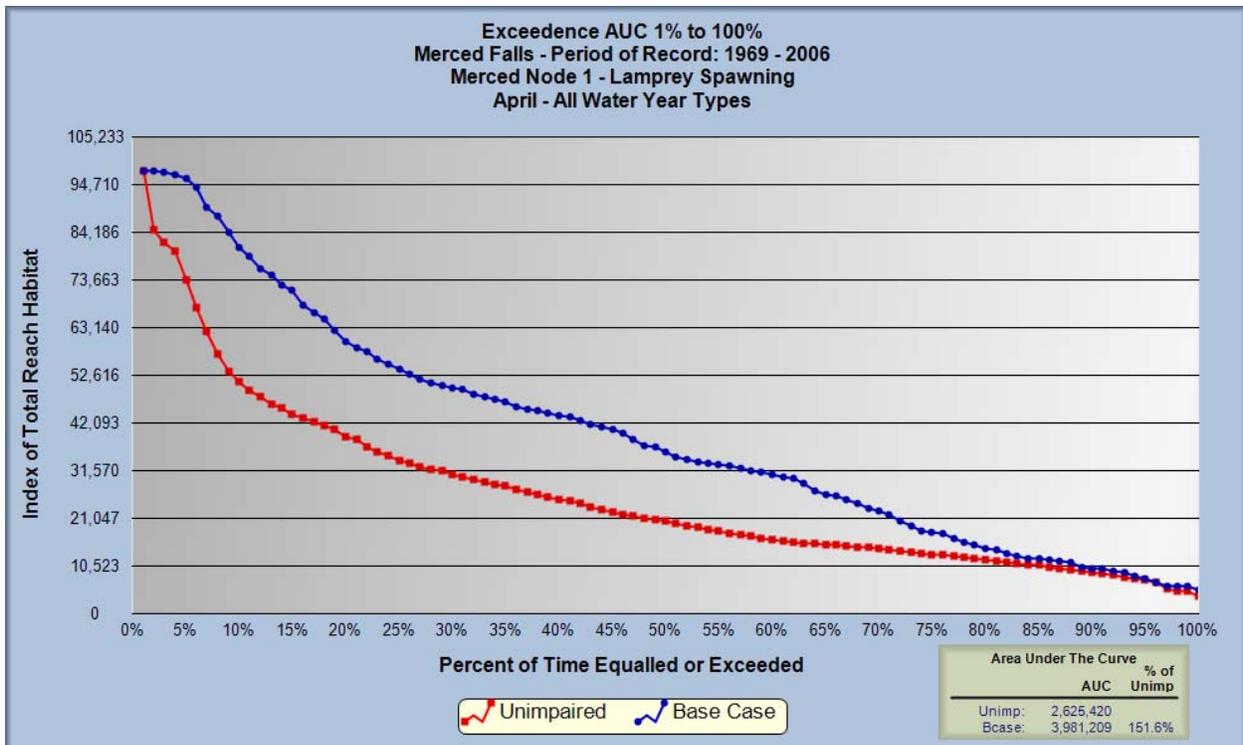


Figure 3.1-50. Habitat exceedance for lamprey spawning in April.

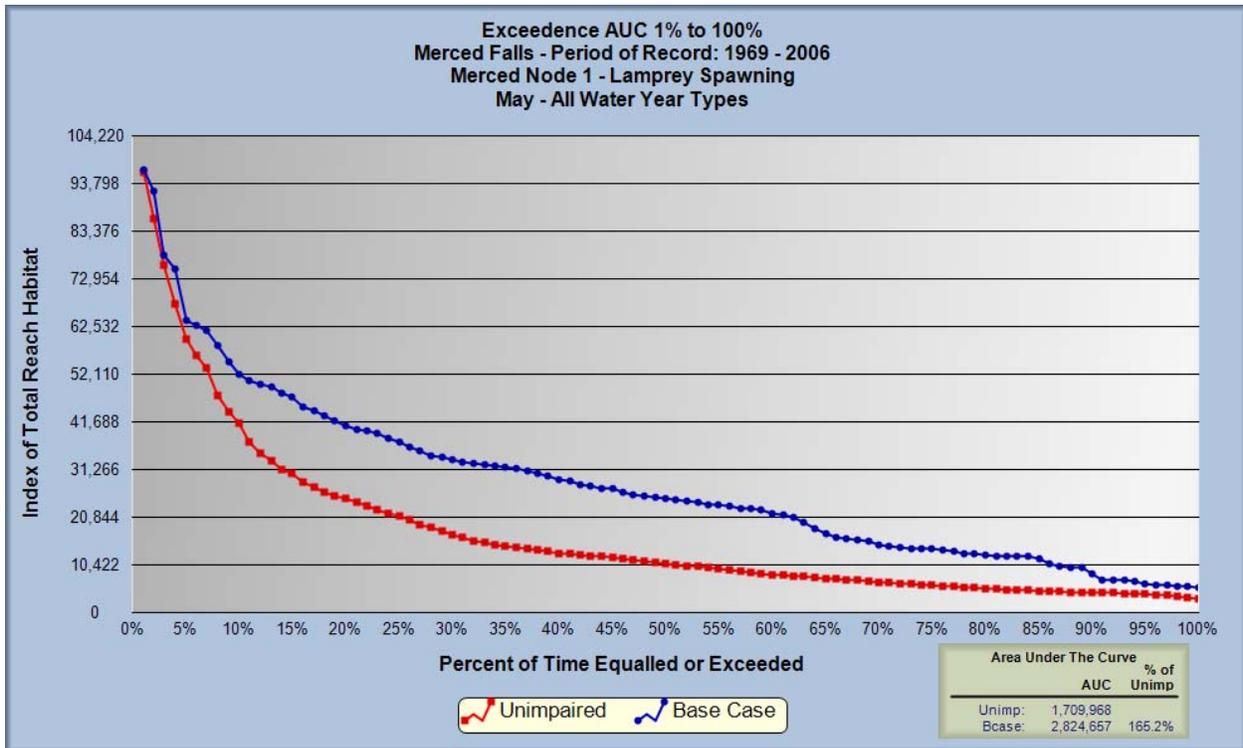


Figure 3.1-51. Habitat exceedance for lamprey spawning in May.

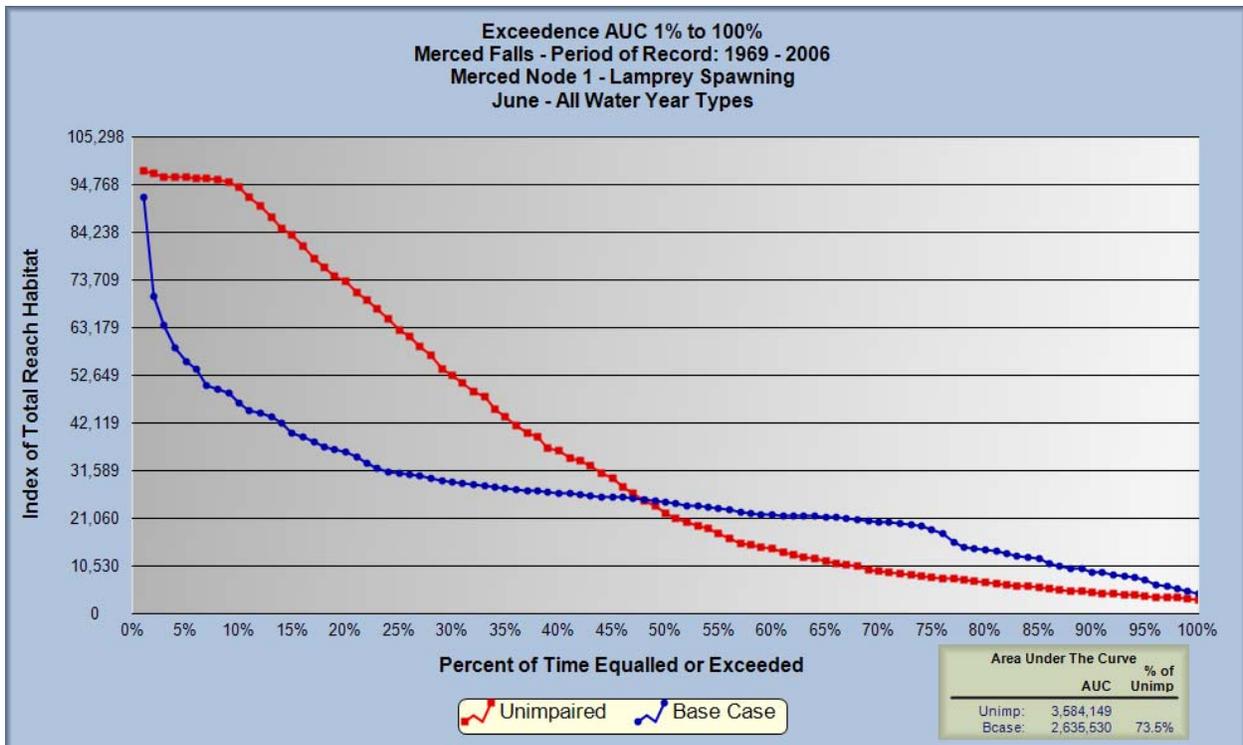


Figure 3.1-52. Habitat exceedance for lamprey spawning in June.

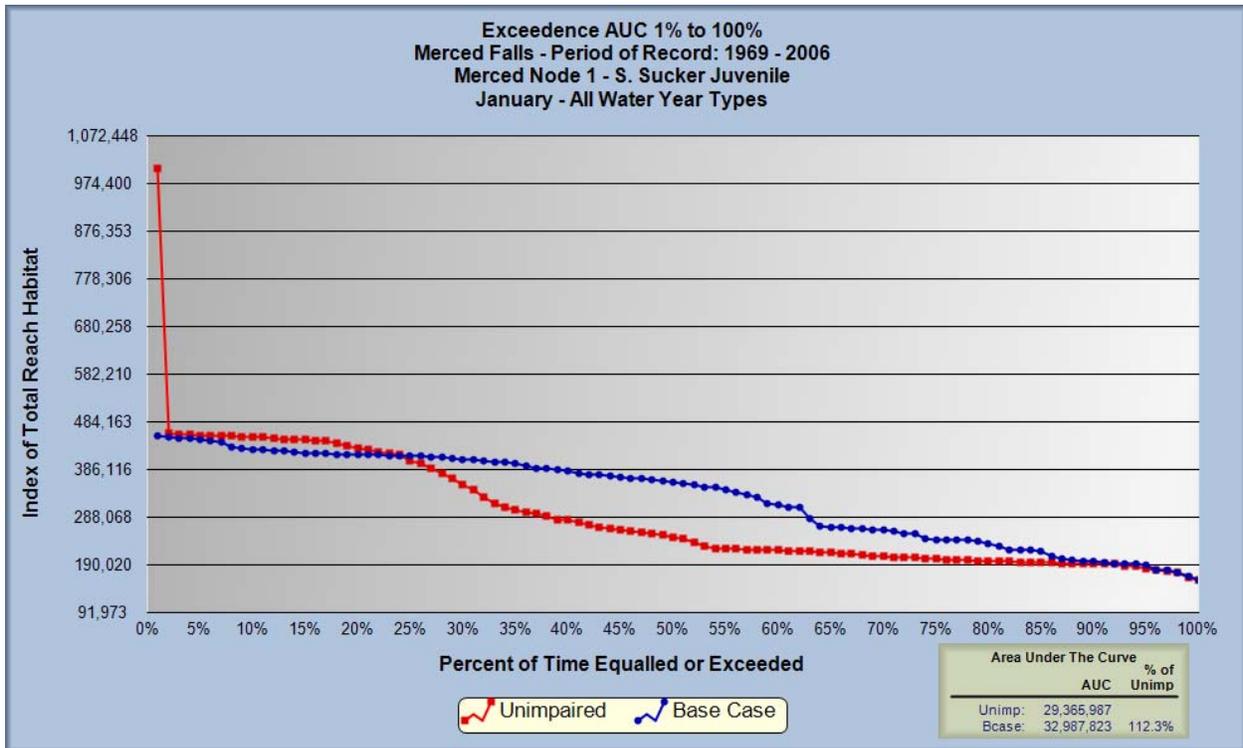


Figure 3.1-53. Habitat exceedance for Sacramento sucker juvenile in January.

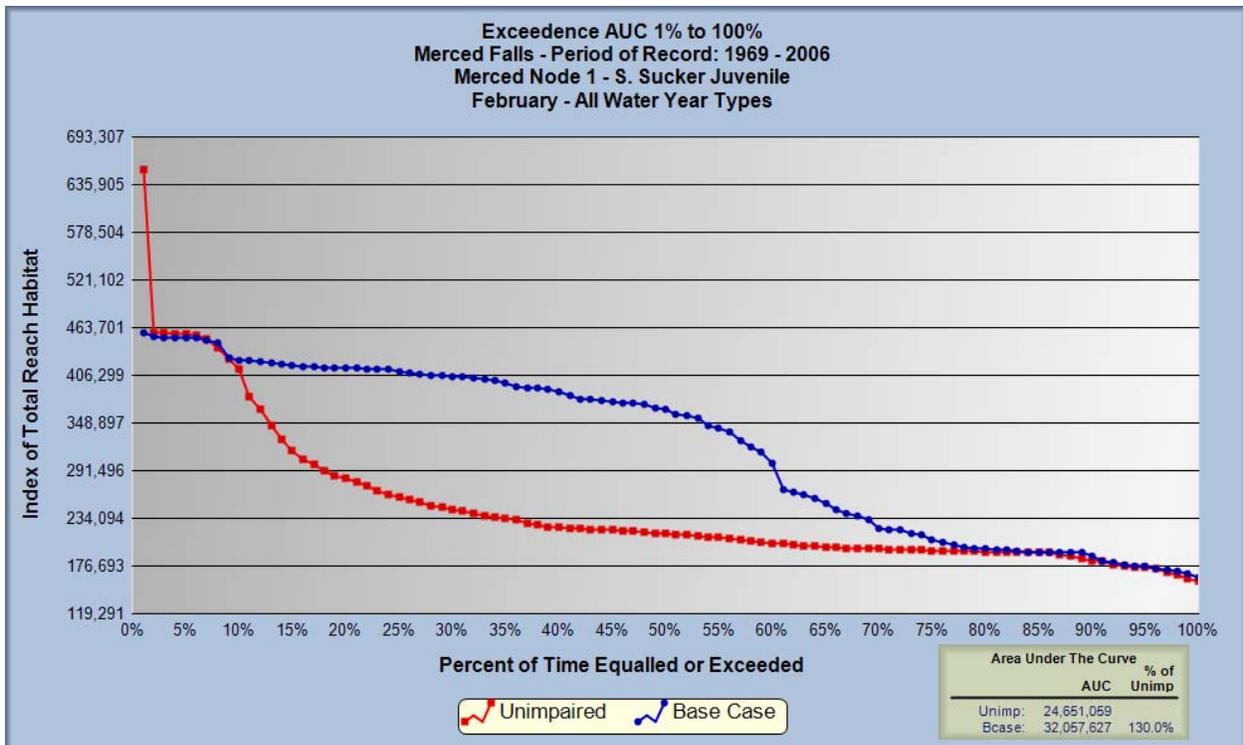


Figure 3.1-54. Habitat exceedance for Sacramento sucker juvenile in February.

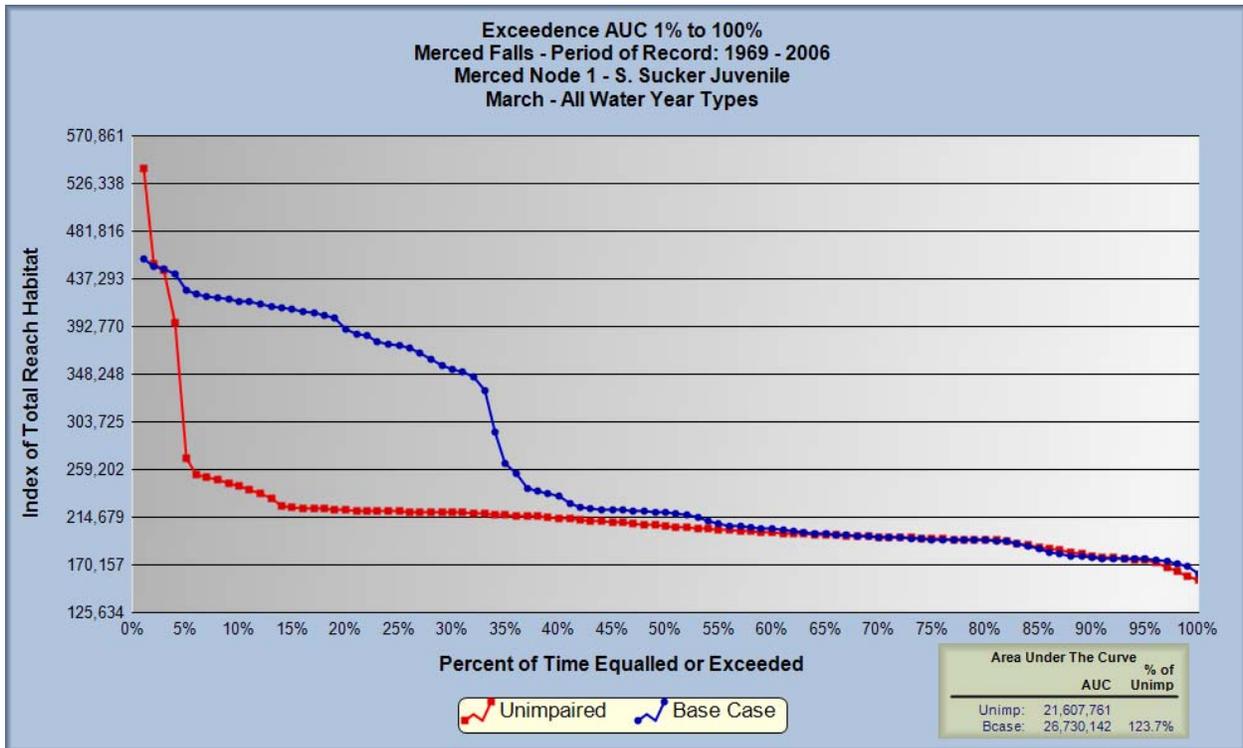


Figure 3.1-55. Habitat exceedance for Sacramento sucker juvenile in March.

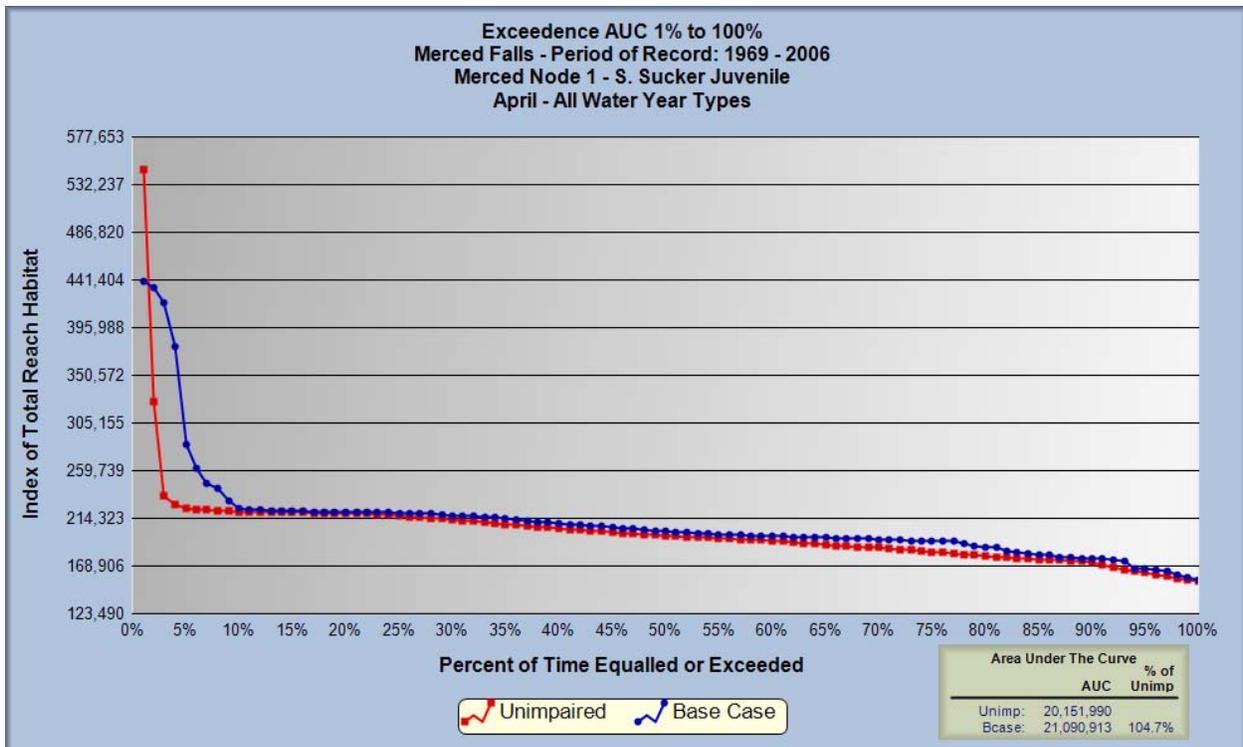


Figure 3.1-56. Habitat exceedance for Sacramento sucker juvenile in April.

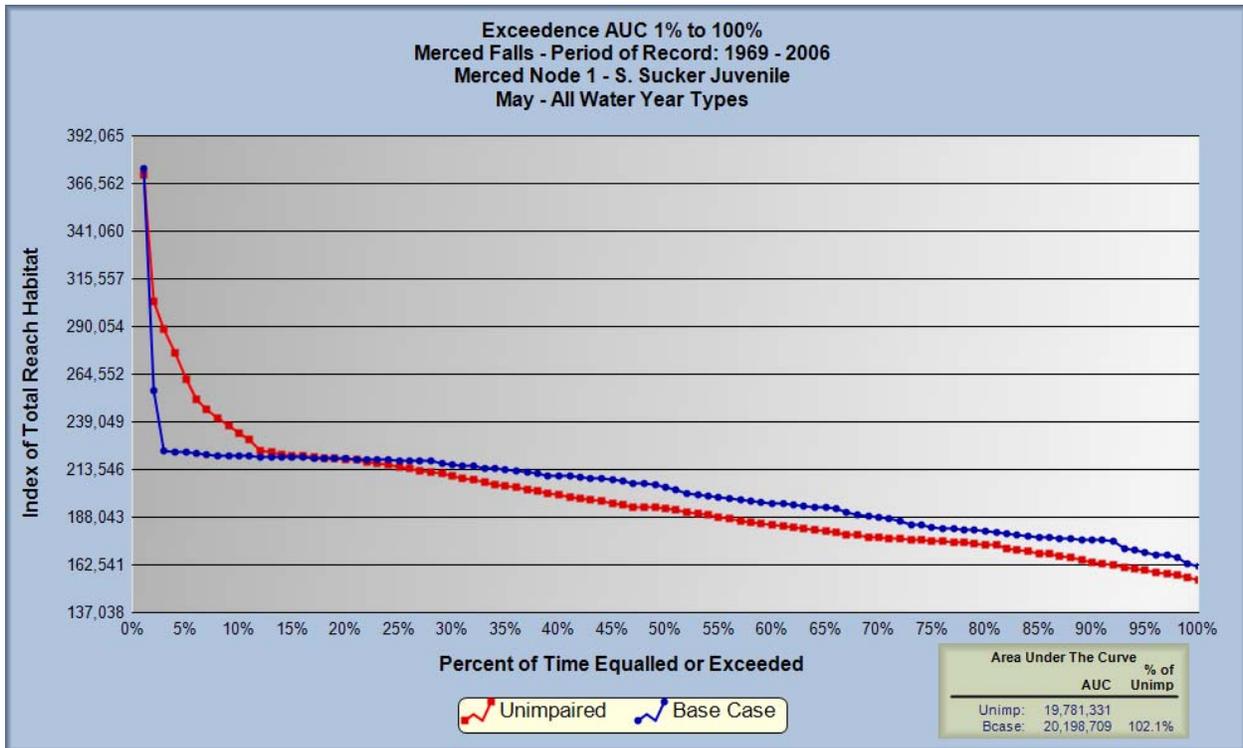


Figure 3.1-57. Habitat exceedance for Sacramento sucker juvenile in May.

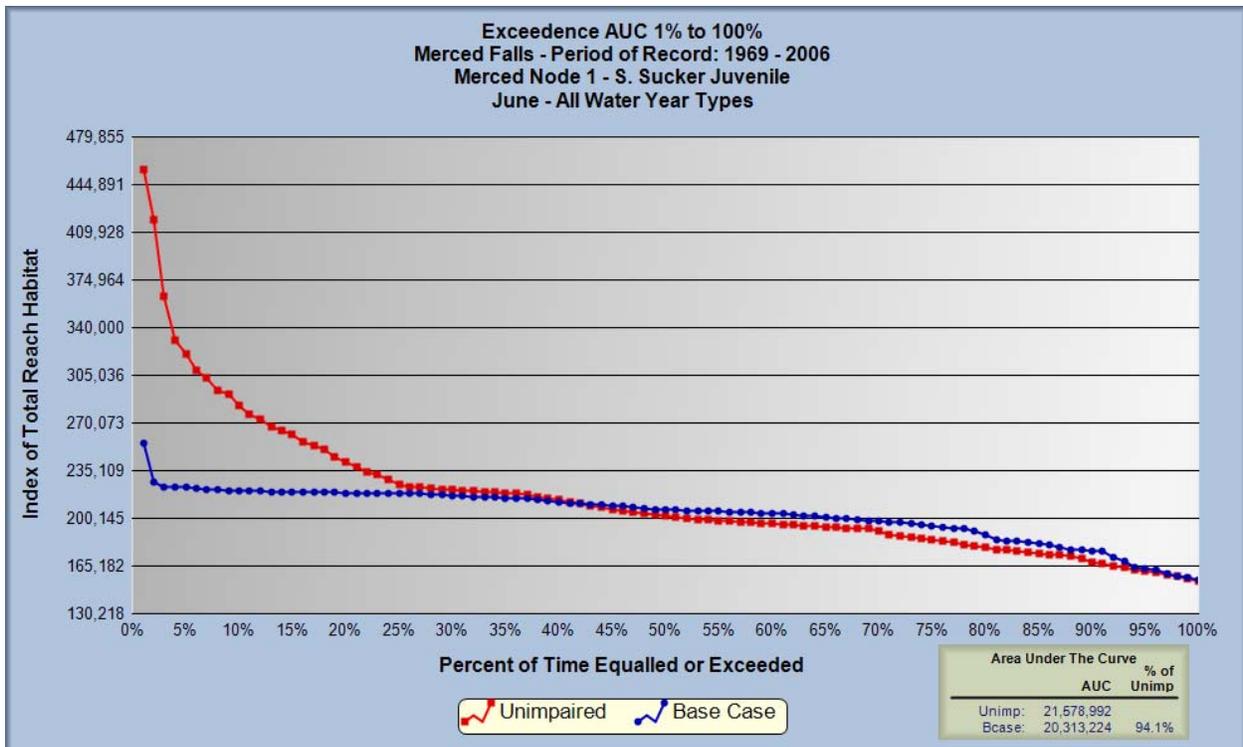


Figure 3.1-58. Habitat exceedance for Sacramento sucker juvenile in June.

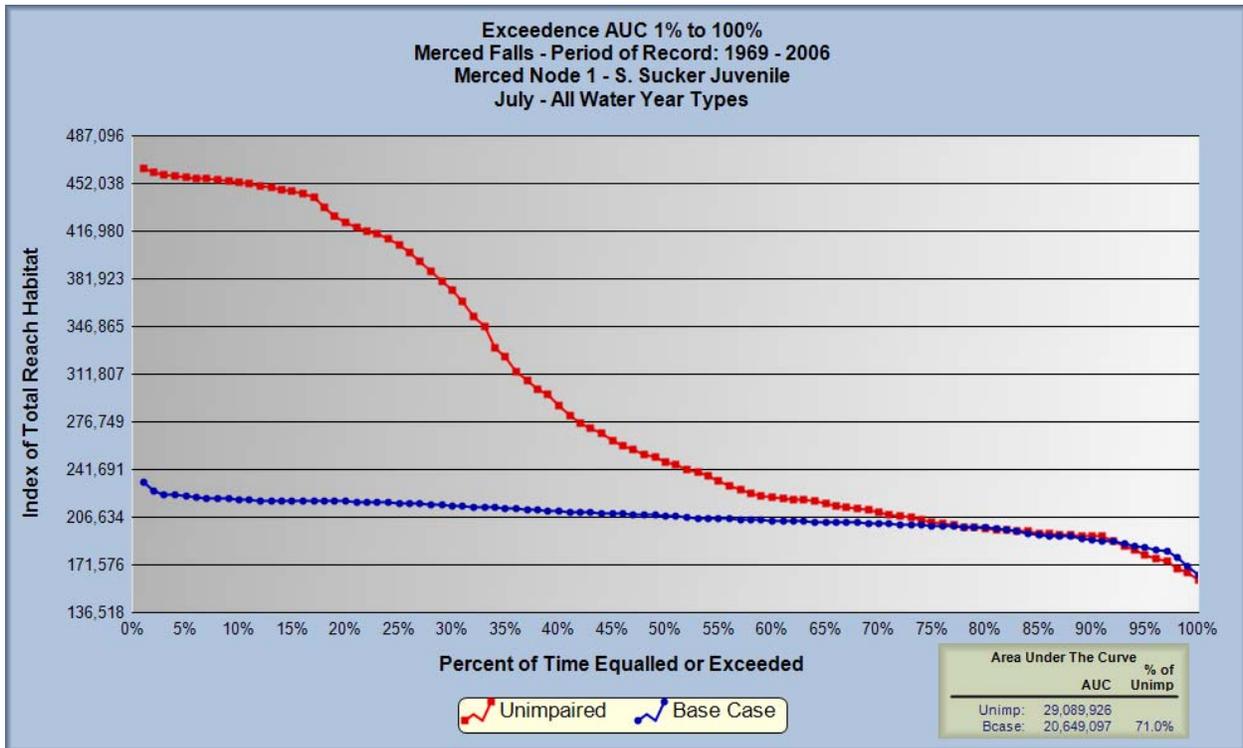


Figure 3.1-59. Habitat exceedance for Sacramento sucker juvenile in July.

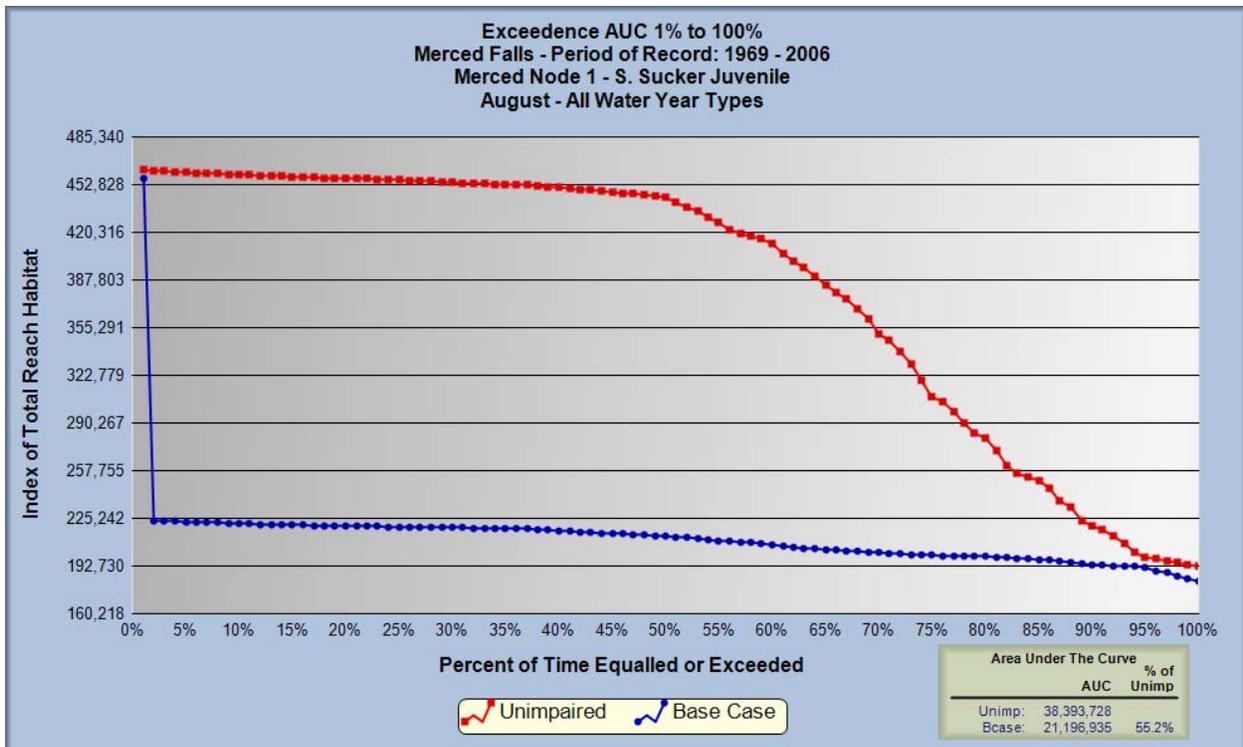


Figure 3.1-60. Habitat exceedance for Sacramento sucker juvenile in August.

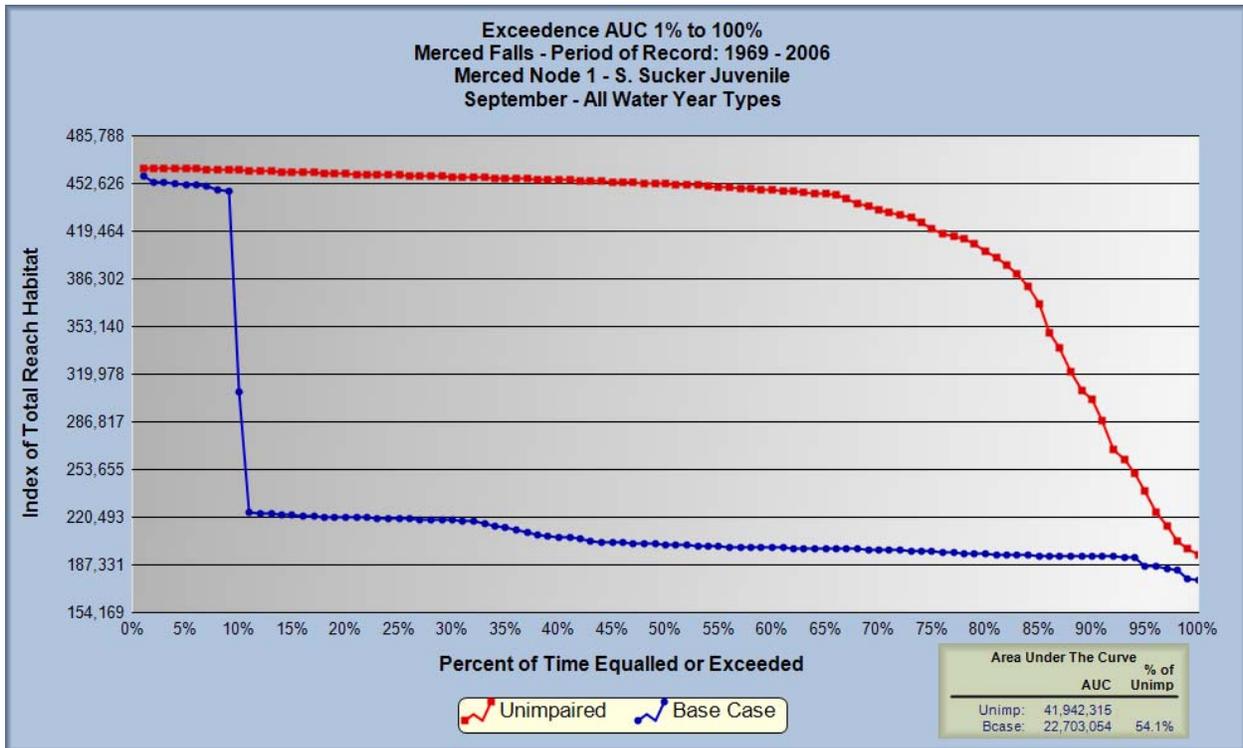


Figure 3.1-61. Habitat exceedance for Sacramento sucker juvenile in September.

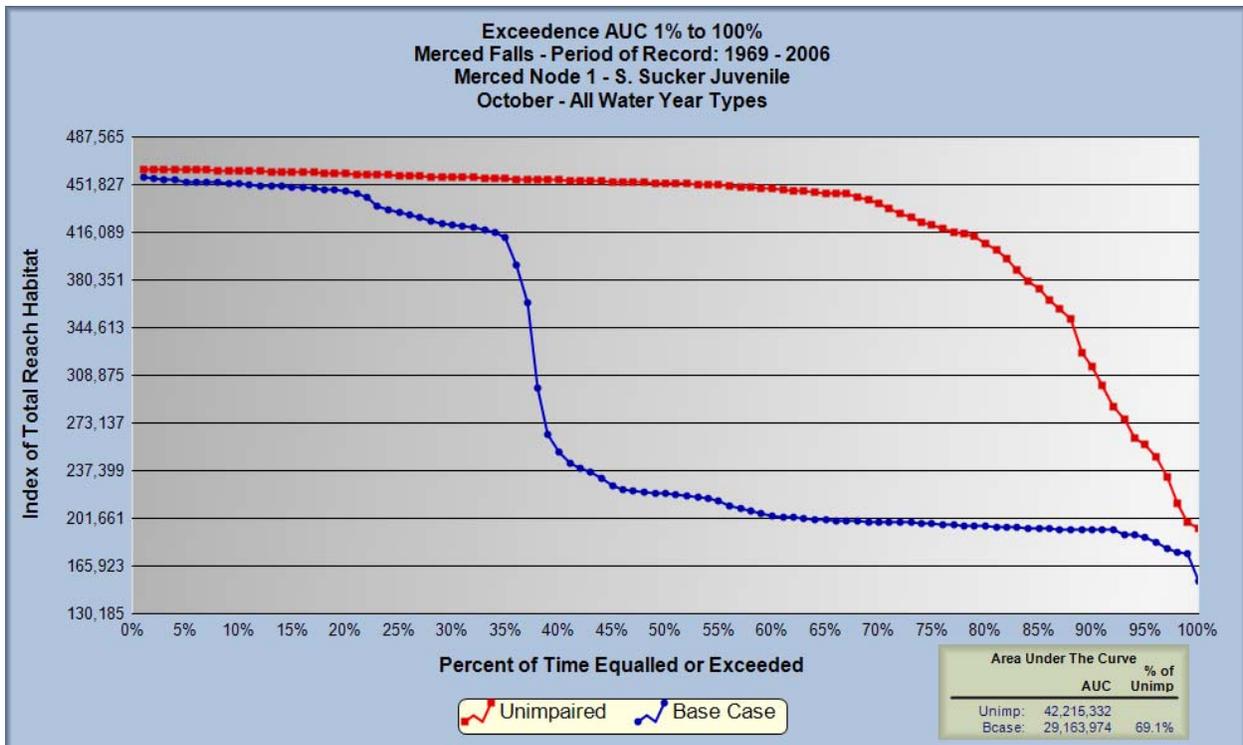


Figure 3.1-62. Habitat exceedance for Sacramento sucker juvenile in October.

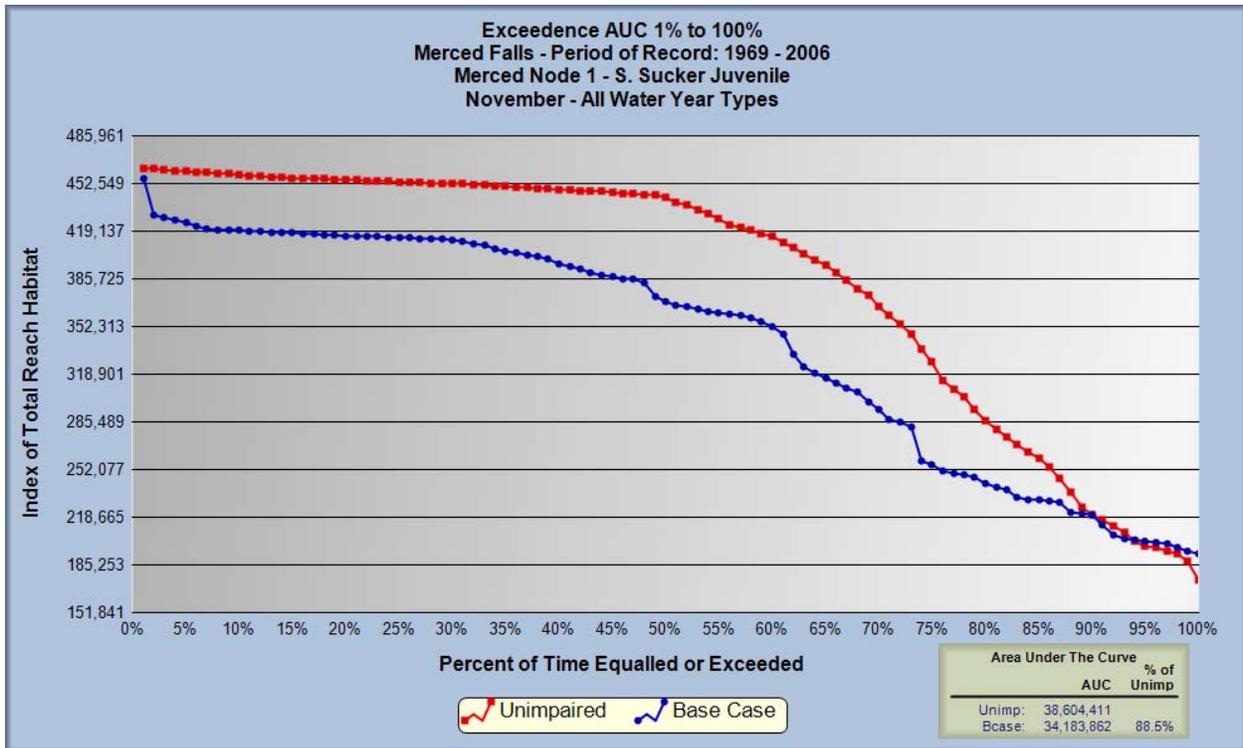


Figure 3.1-63. Habitat exceedance for Sacramento sucker juvenile in November.

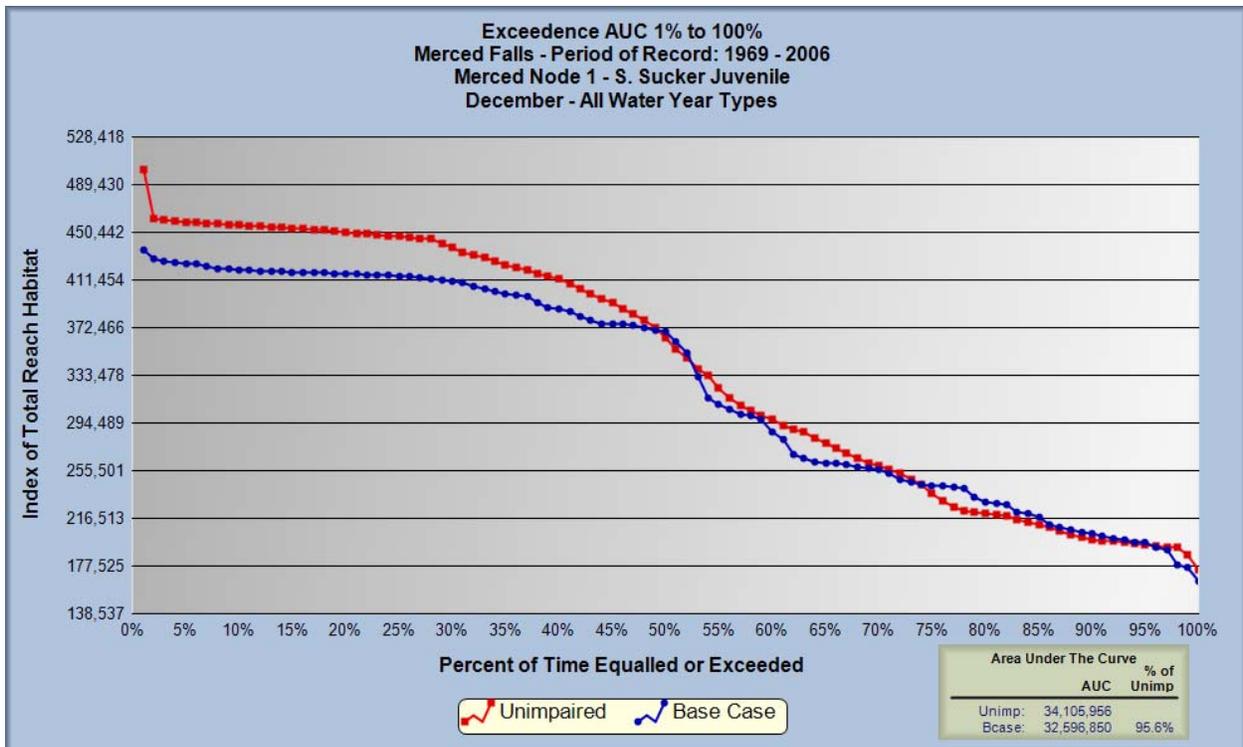


Figure 3.1-64. Habitat exceedance for Sacramento sucker juvenile in December.

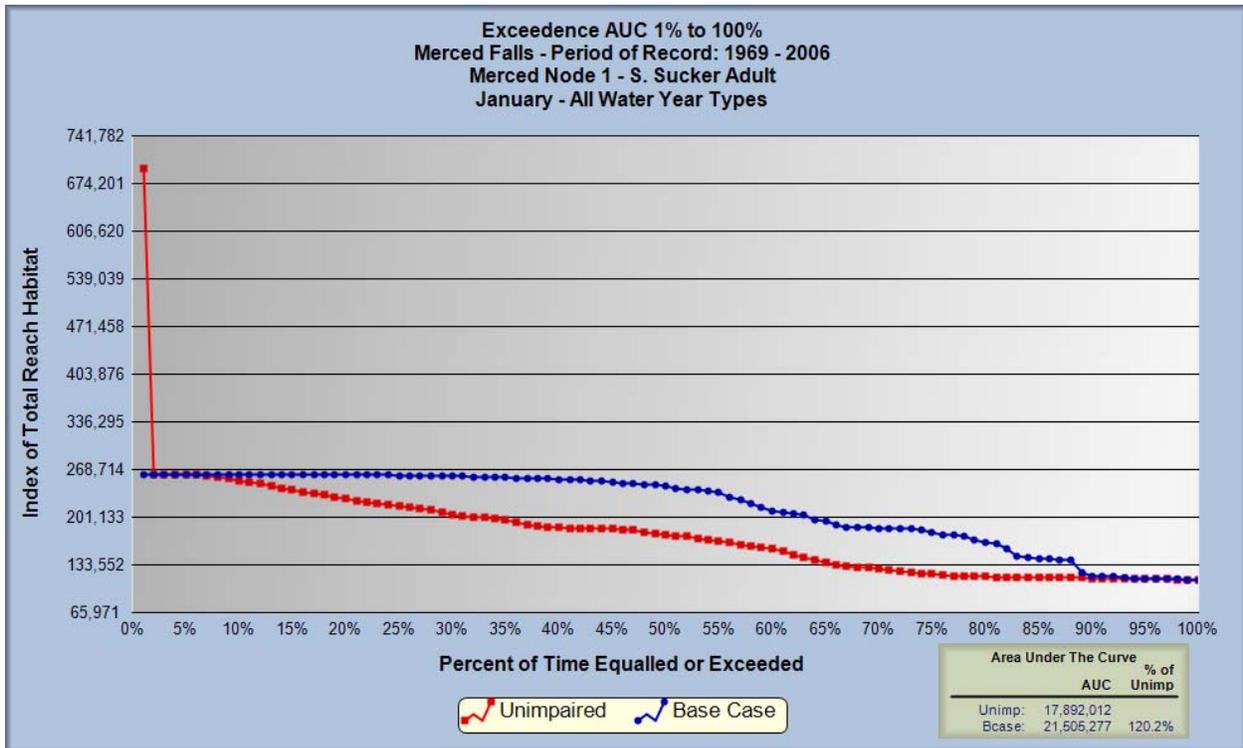


Figure 3.1-65. Habitat exceedance for Sacramento sucker adult in January.

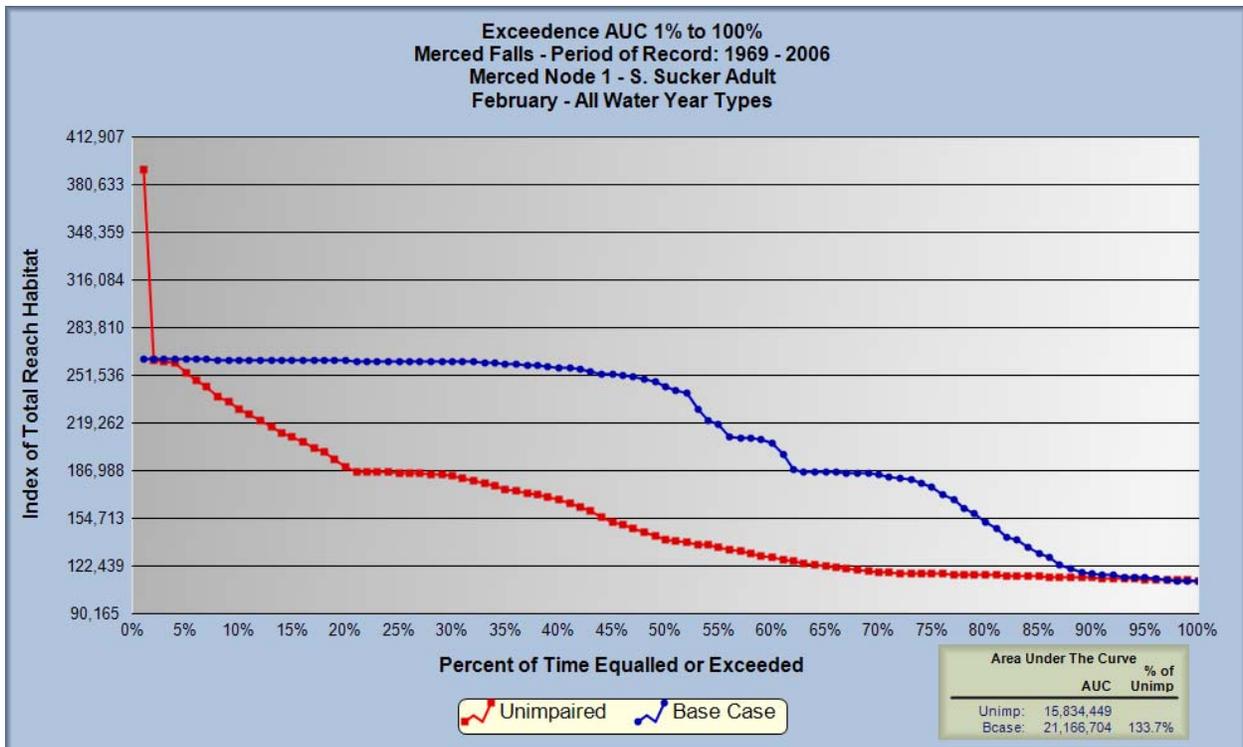


Figure 3.1-66. Habitat exceedance for Sacramento sucker adult in February.

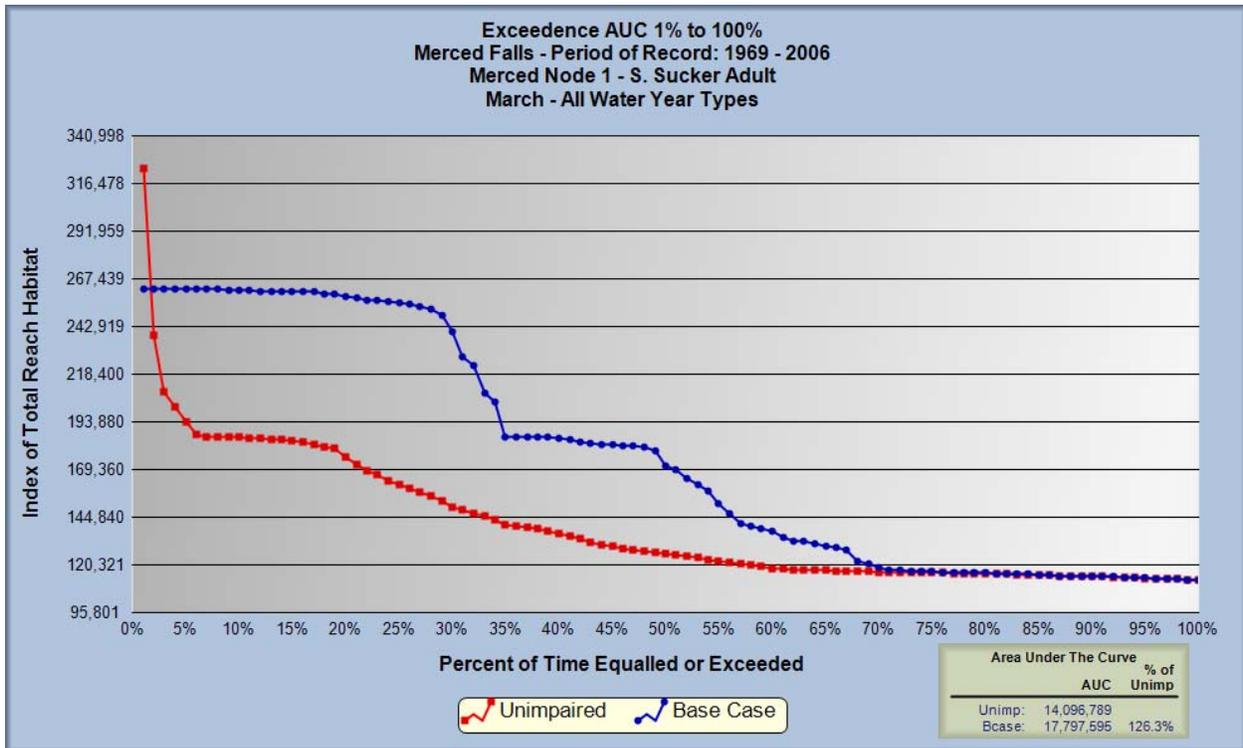


Figure 3.1-67. Habitat exceedance for Sacramento sucker adult in March.

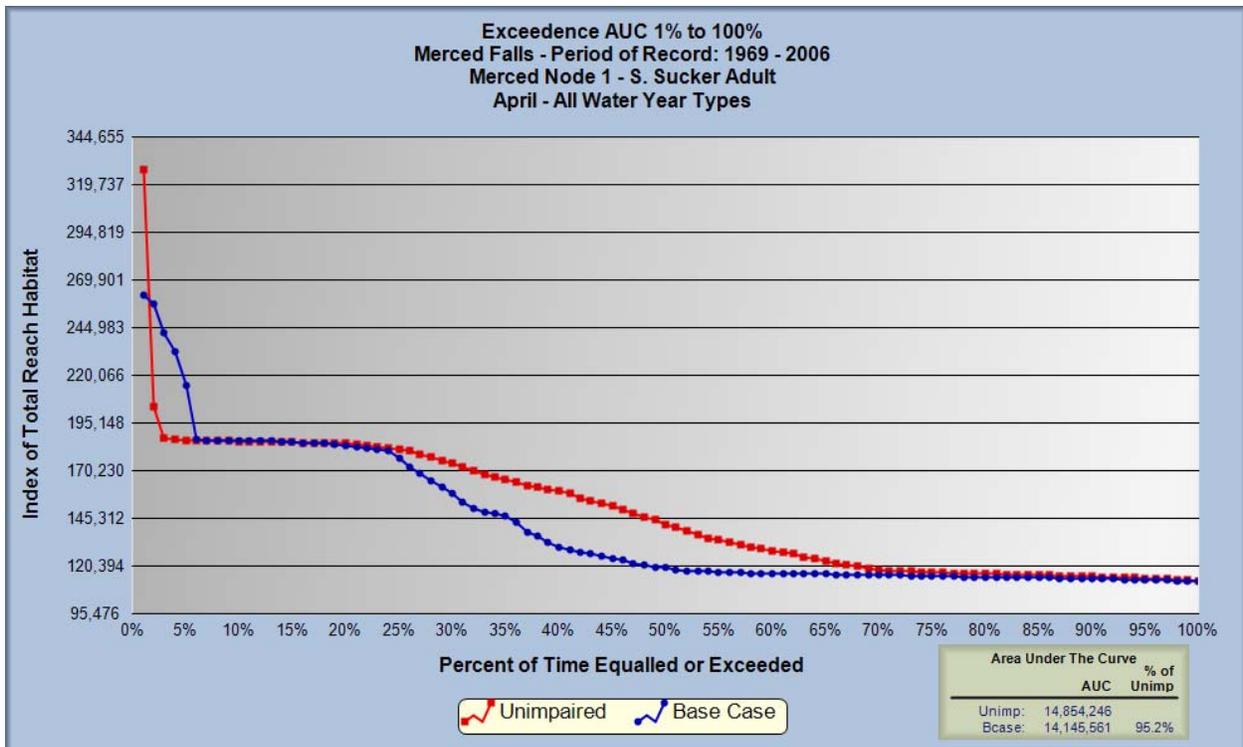


Figure 3.1-68. Habitat exceedance for Sacramento sucker adult in April.

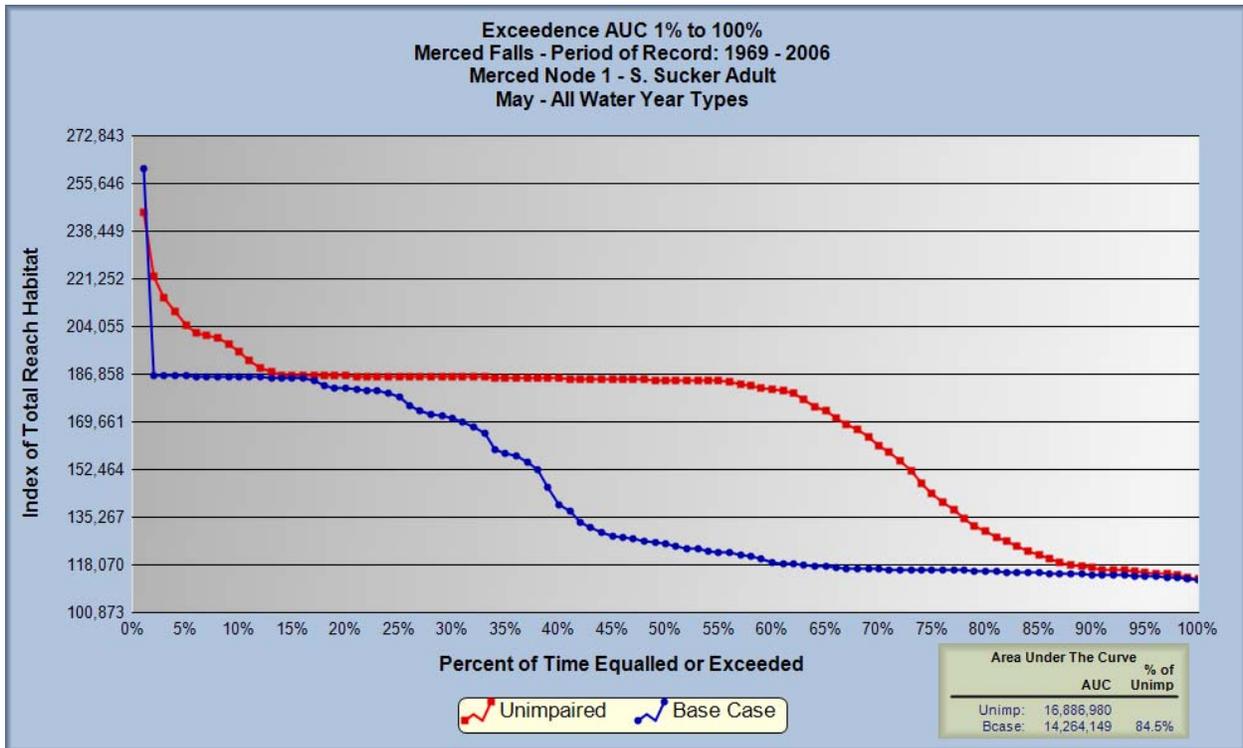


Figure 3.1-69. Habitat exceedance for Sacramento sucker adult in May.

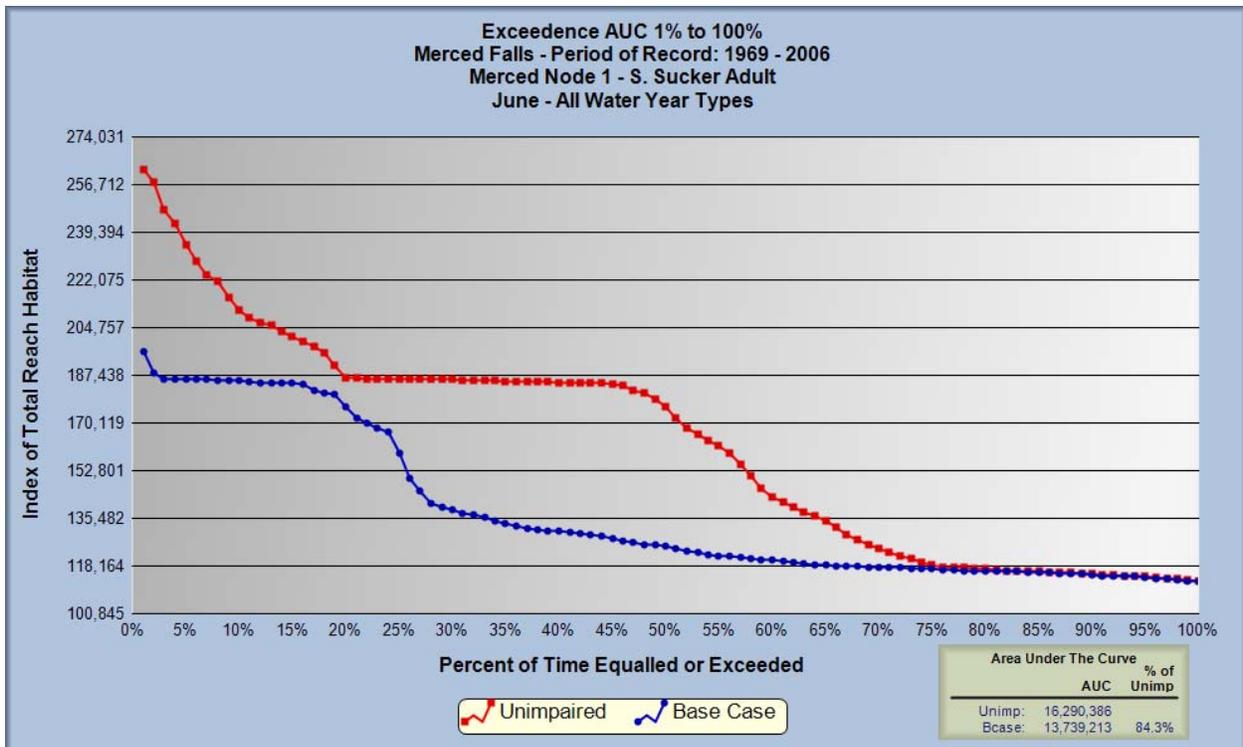


Figure 3.1-70. Habitat exceedance for Sacramento sucker adult in June.

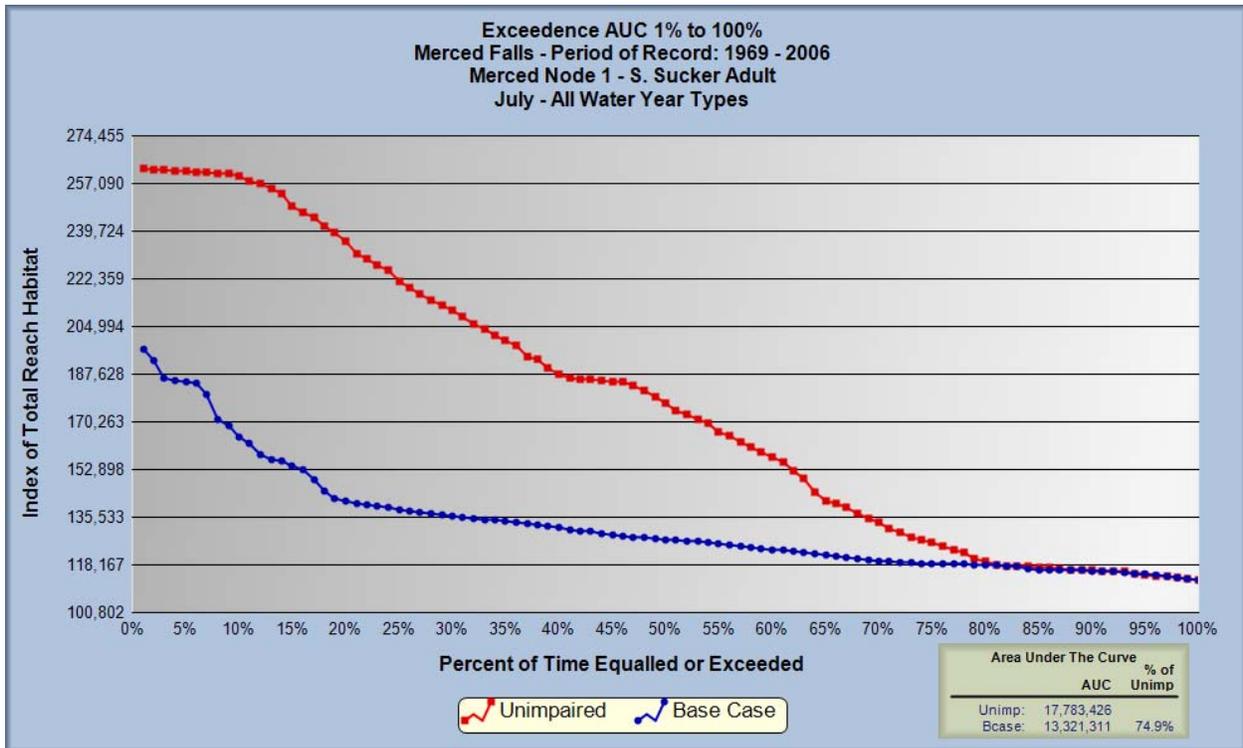


Figure 3.1-71. Habitat exceedance for Sacramento sucker adult in July.

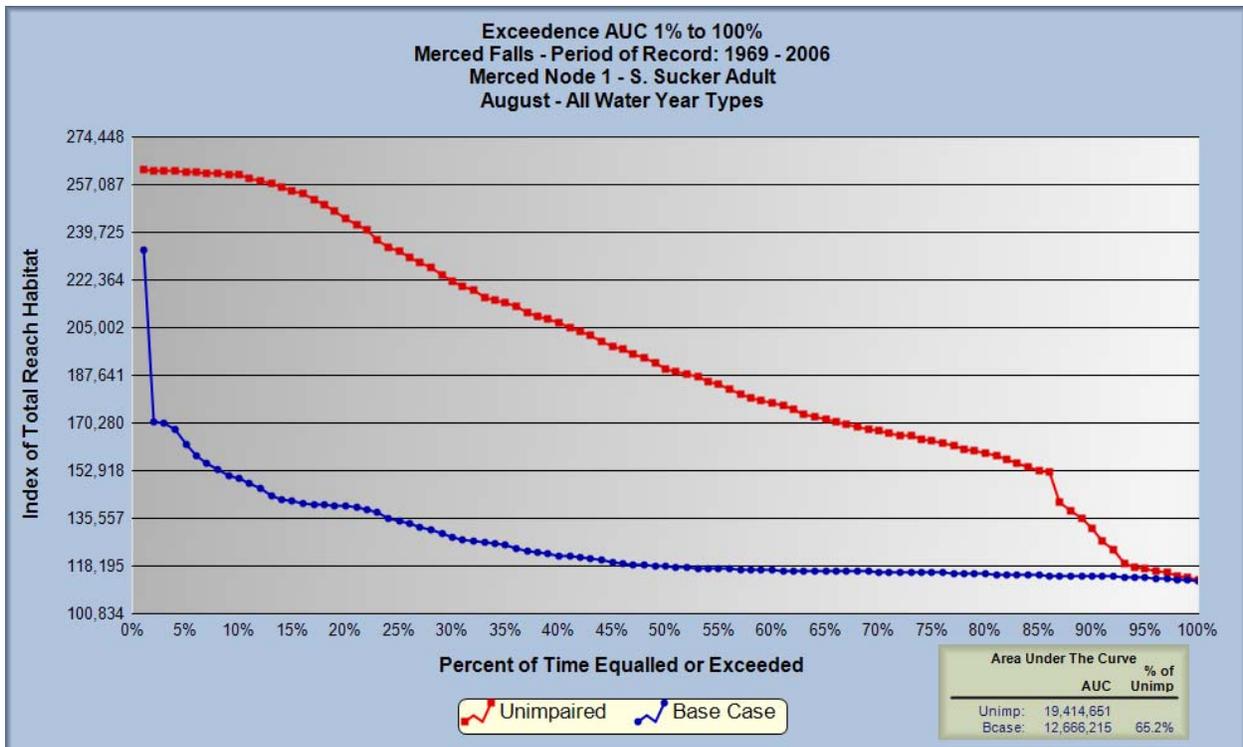


Figure 3.1-72. Habitat exceedance for Sacramento sucker adult in August.

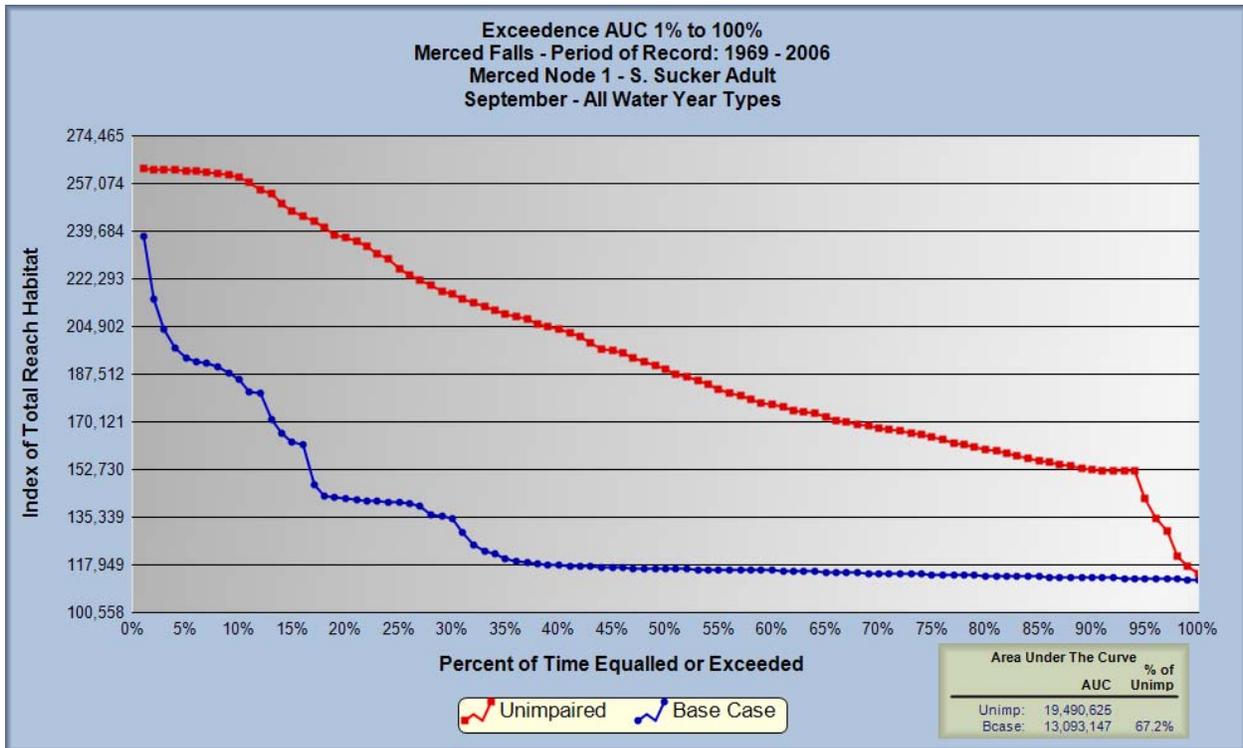


Figure 3.1-73. Habitat exceedance for Sacramento sucker adult in September.

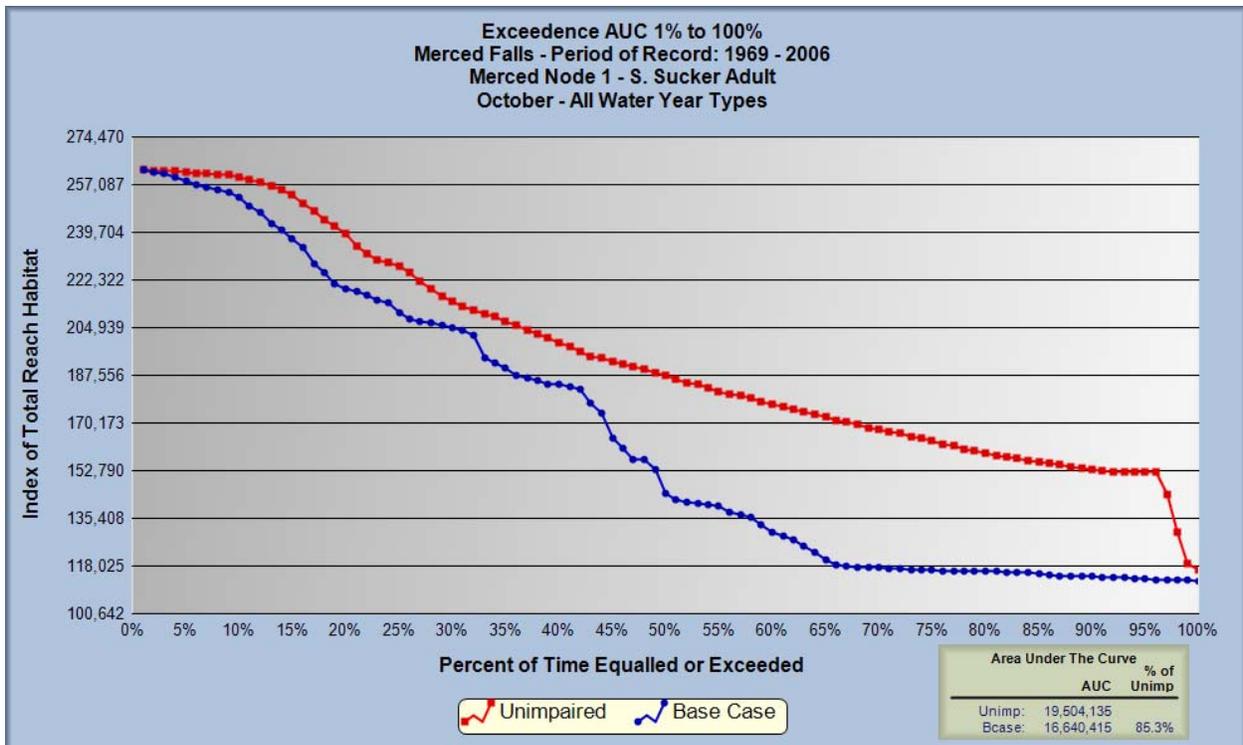


Figure 3.1-74. Habitat exceedance for Sacramento sucker adult in October.

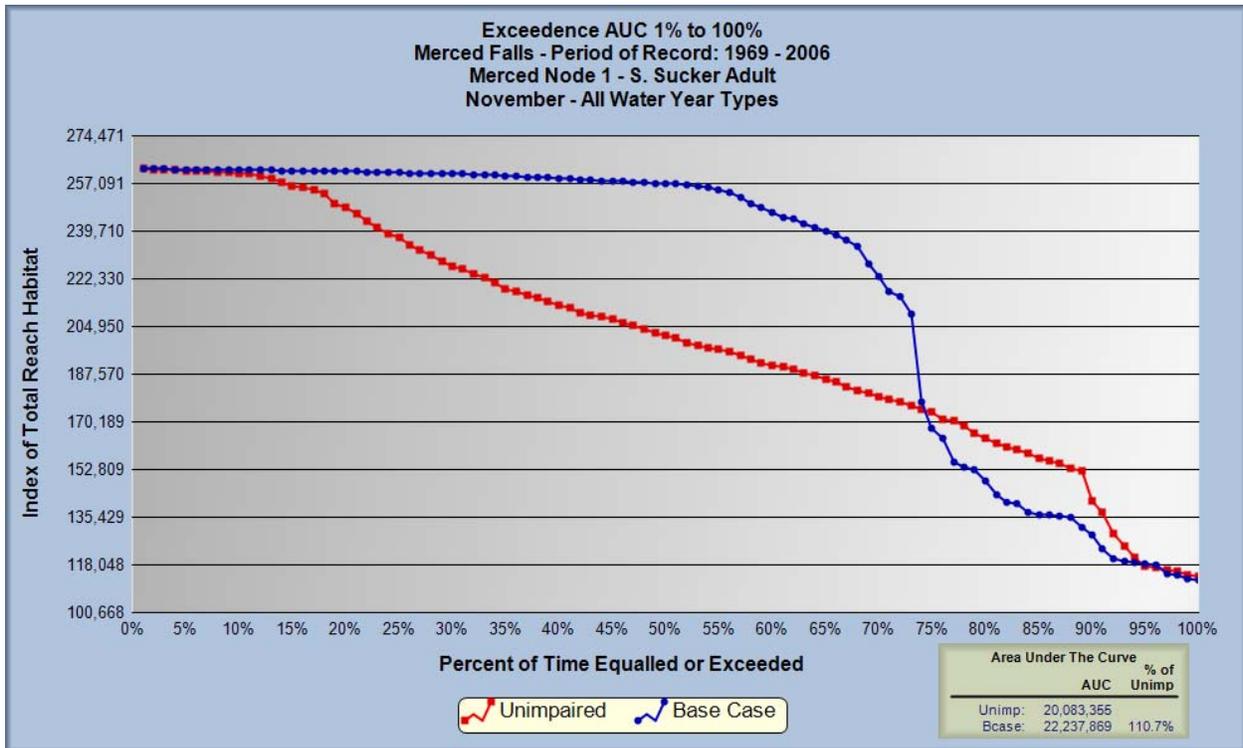


Figure 3.1-75. Habitat exceedance for Sacramento sucker adult in November.

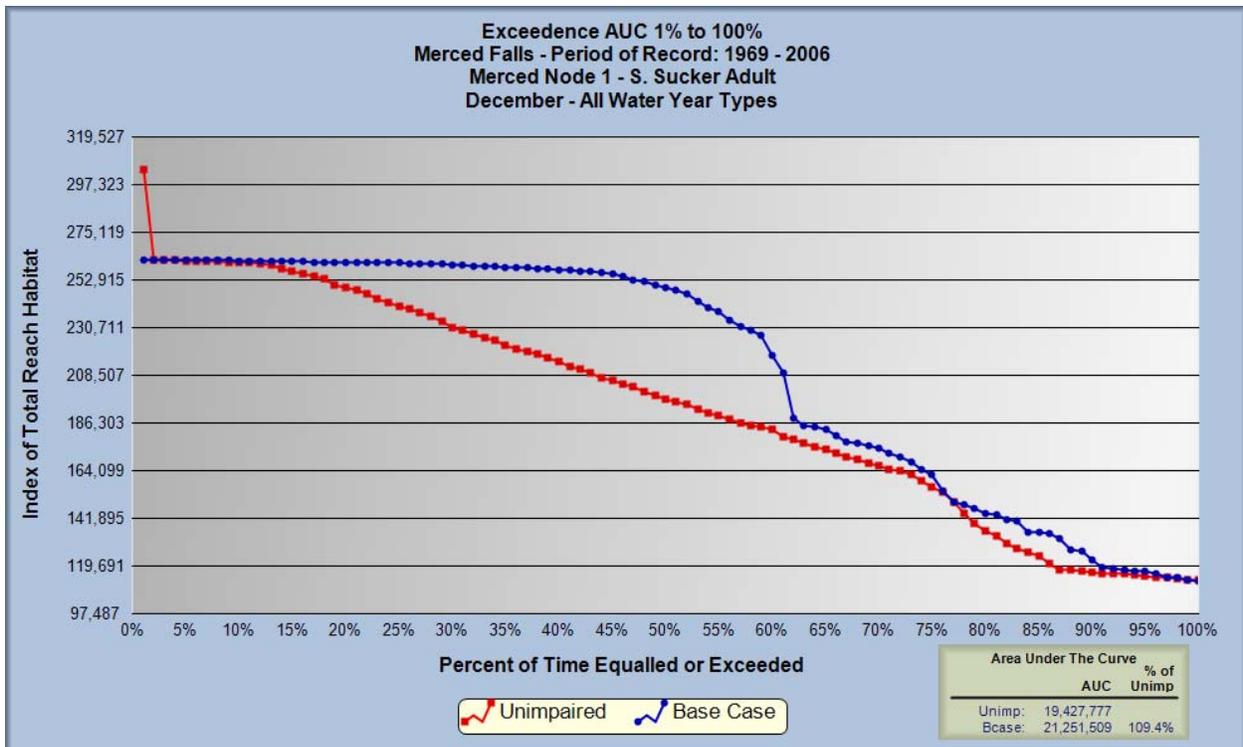


Figure 3.1-76. Habitat exceedance for Sacramento sucker adult in December.

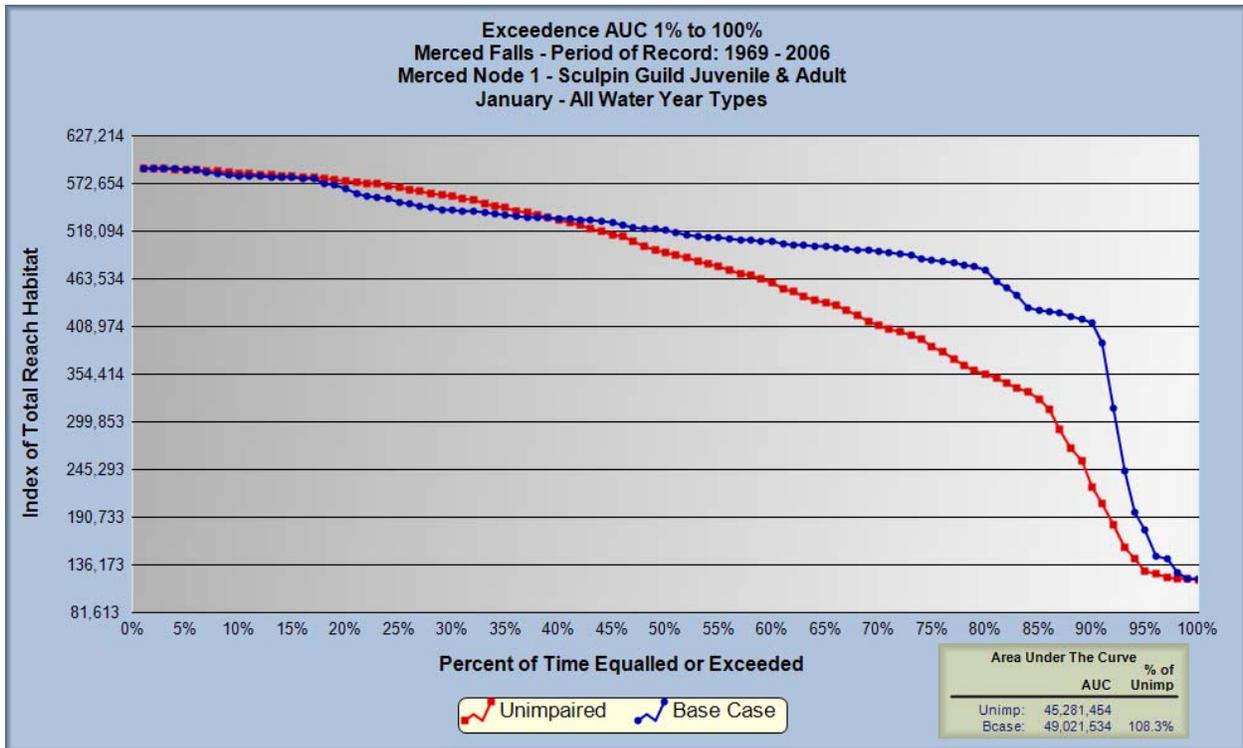


Figure 3.1-77. Habitat exceedance for sculpin guild (juvenile and adult) in January.

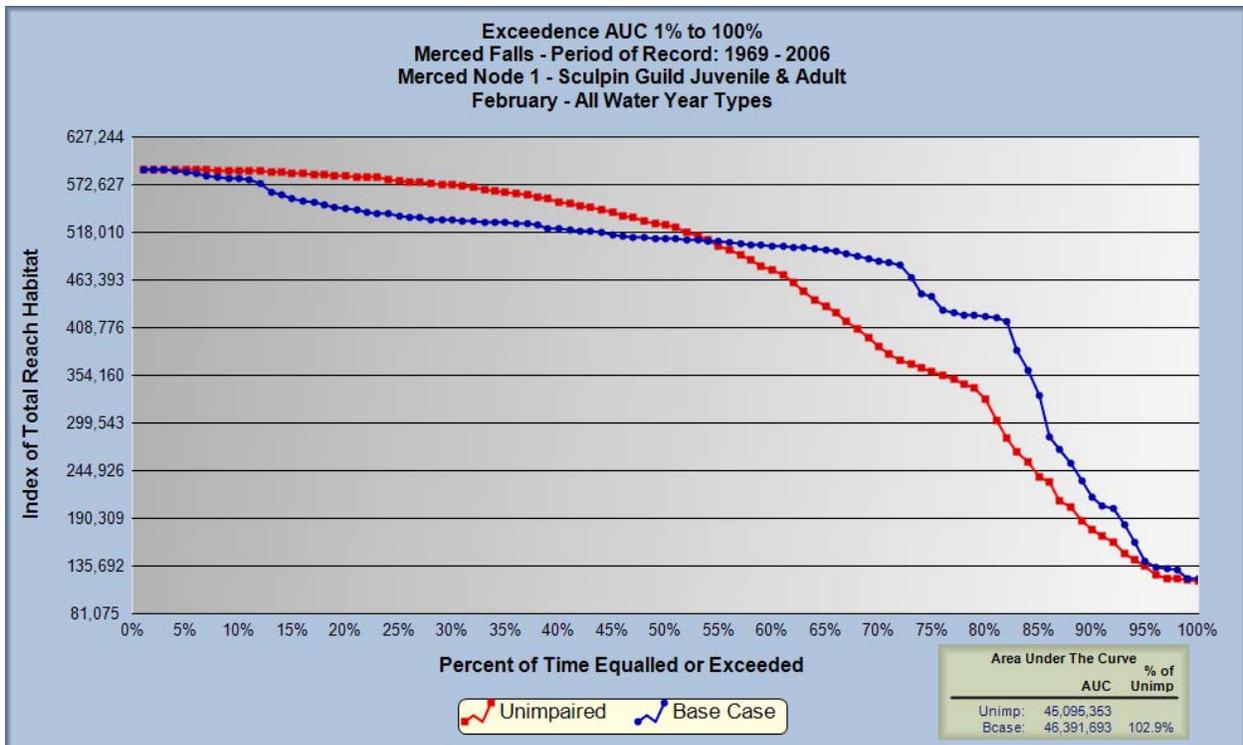


Figure 3.1-78. Habitat exceedance for sculpin guild (juvenile and adult) in February.

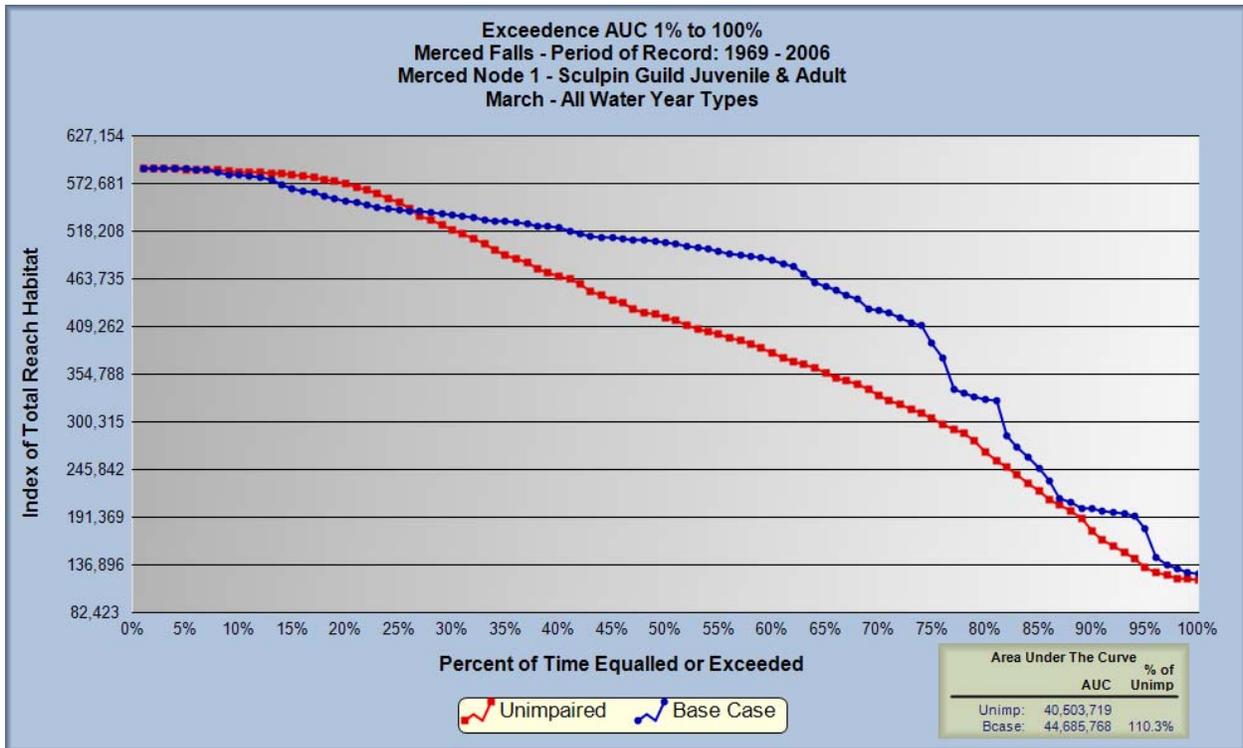


Figure 3.1-79. Habitat exceedance for sculpin guild (juvenile and adult) in March.

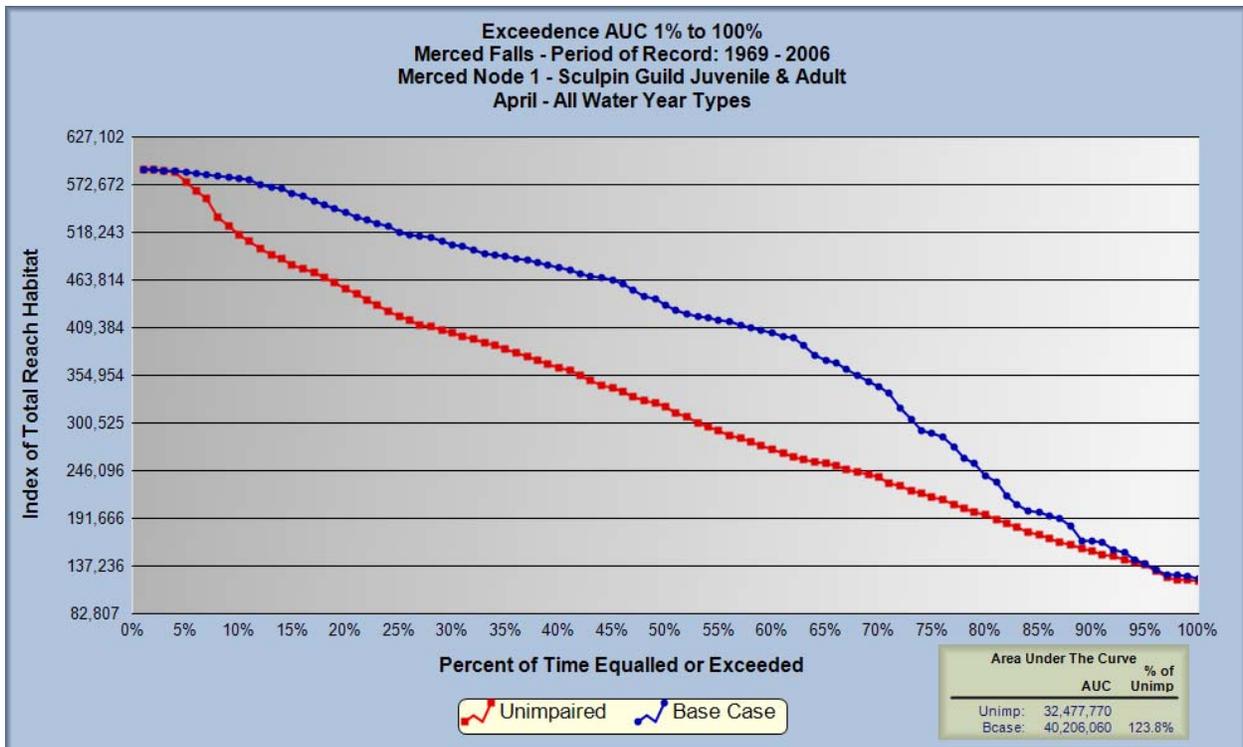


Figure 3.1-80. Habitat exceedance for sculpin guild (juvenile and adult) in April.

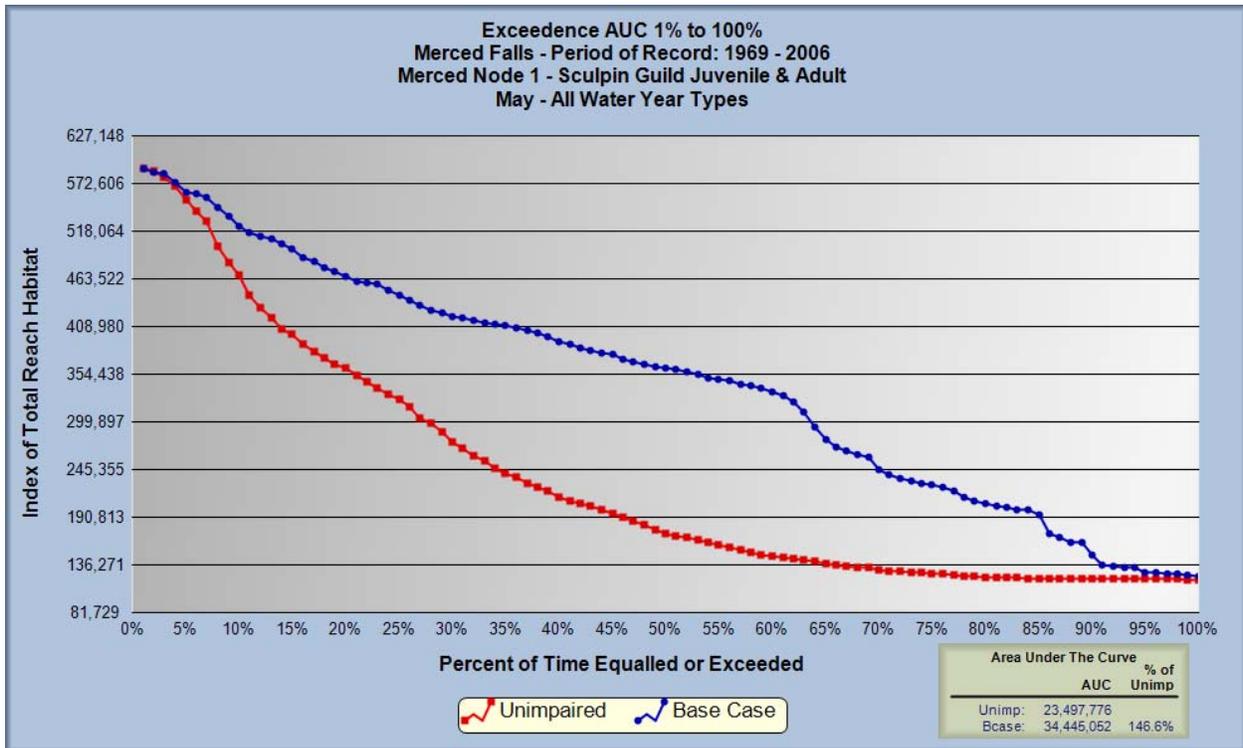


Figure 3.1-81. Habitat exceedance for sculpin guild (juvenile and adult) in May.

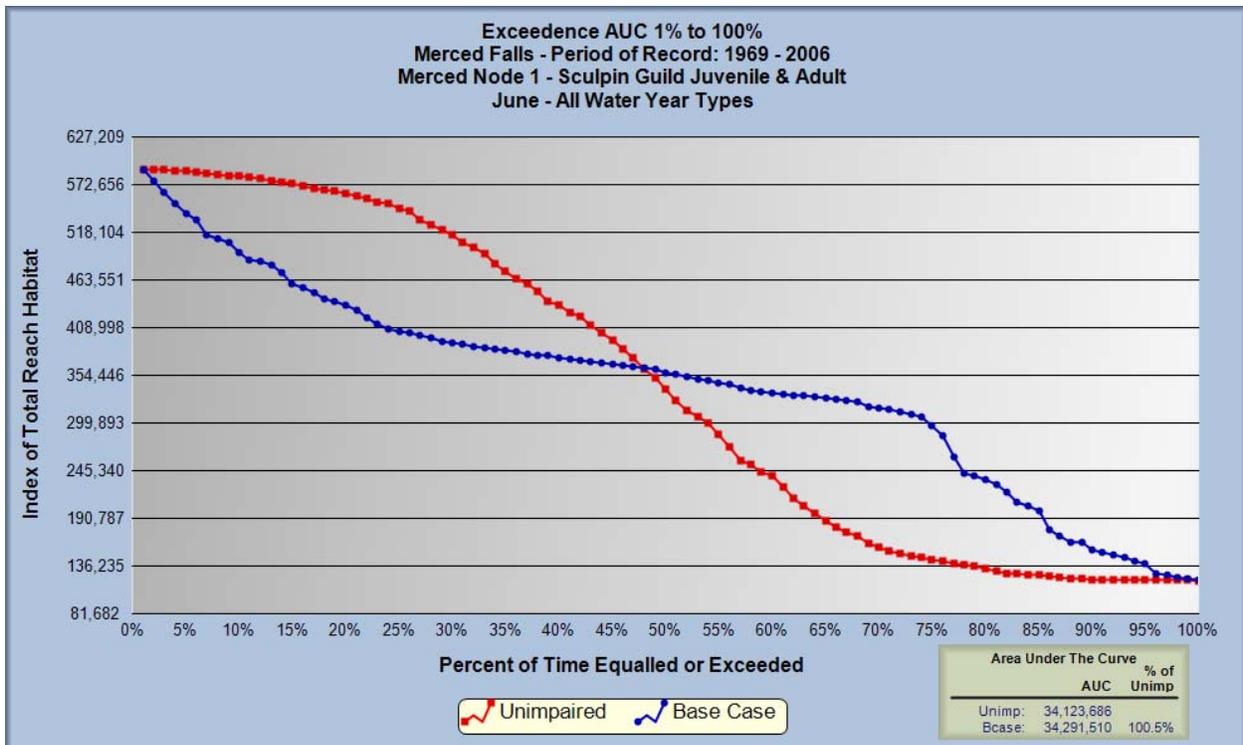


Figure 3.1-82. Habitat exceedance for sculpin guild (juvenile and adult) in June.

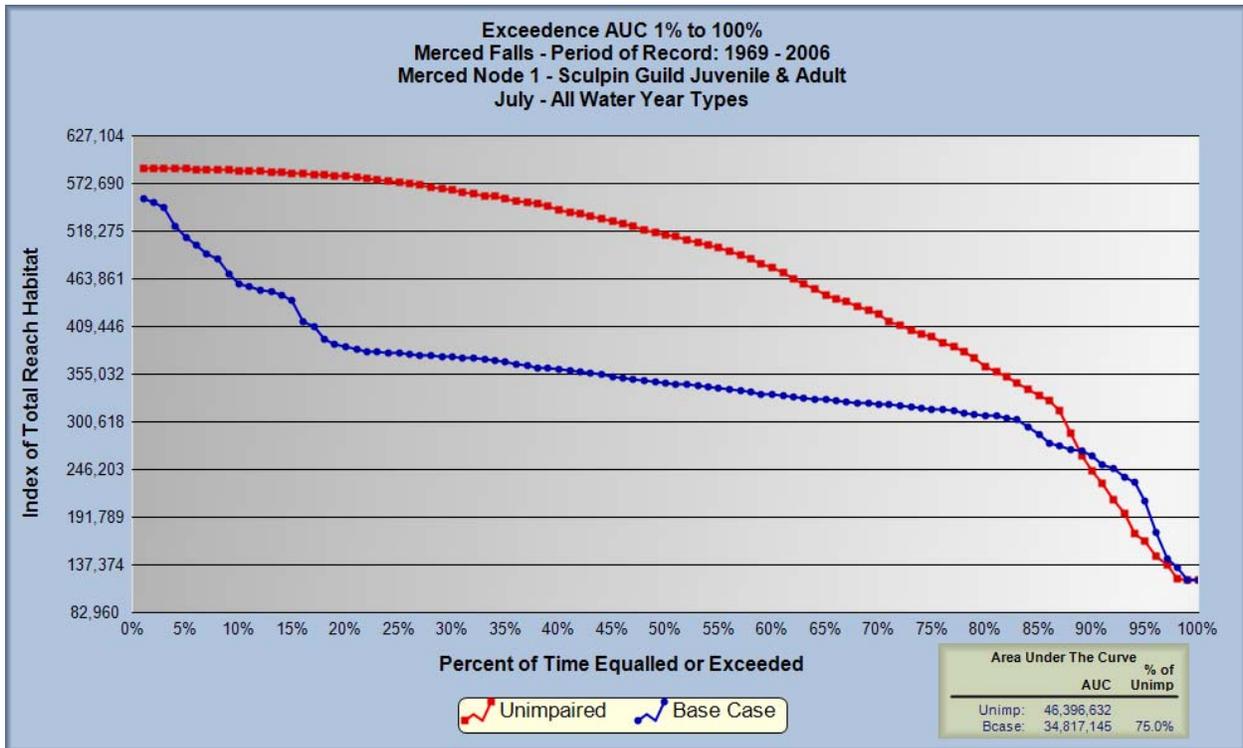


Figure 3.1-83. Habitat exceedance for sculpin guild (juvenile and adult) in July.

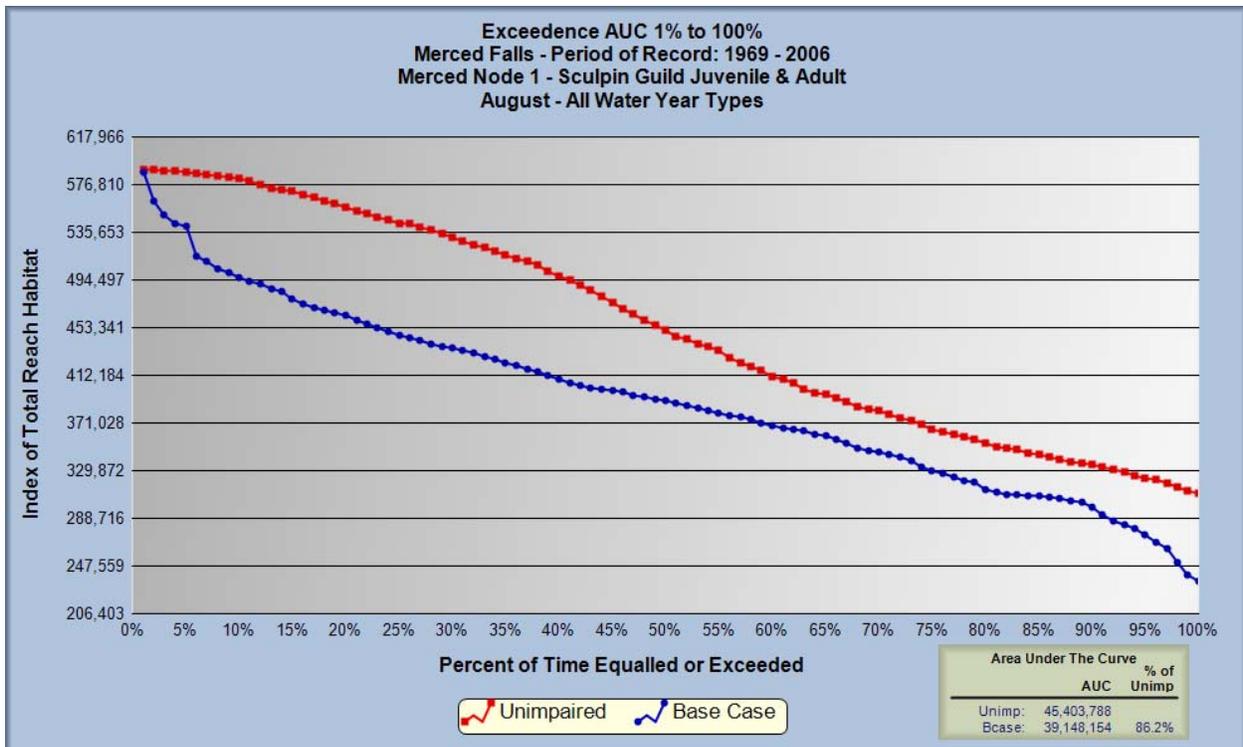


Figure 3.1-84. Habitat exceedance for sculpin guild (juvenile and adult) in August.

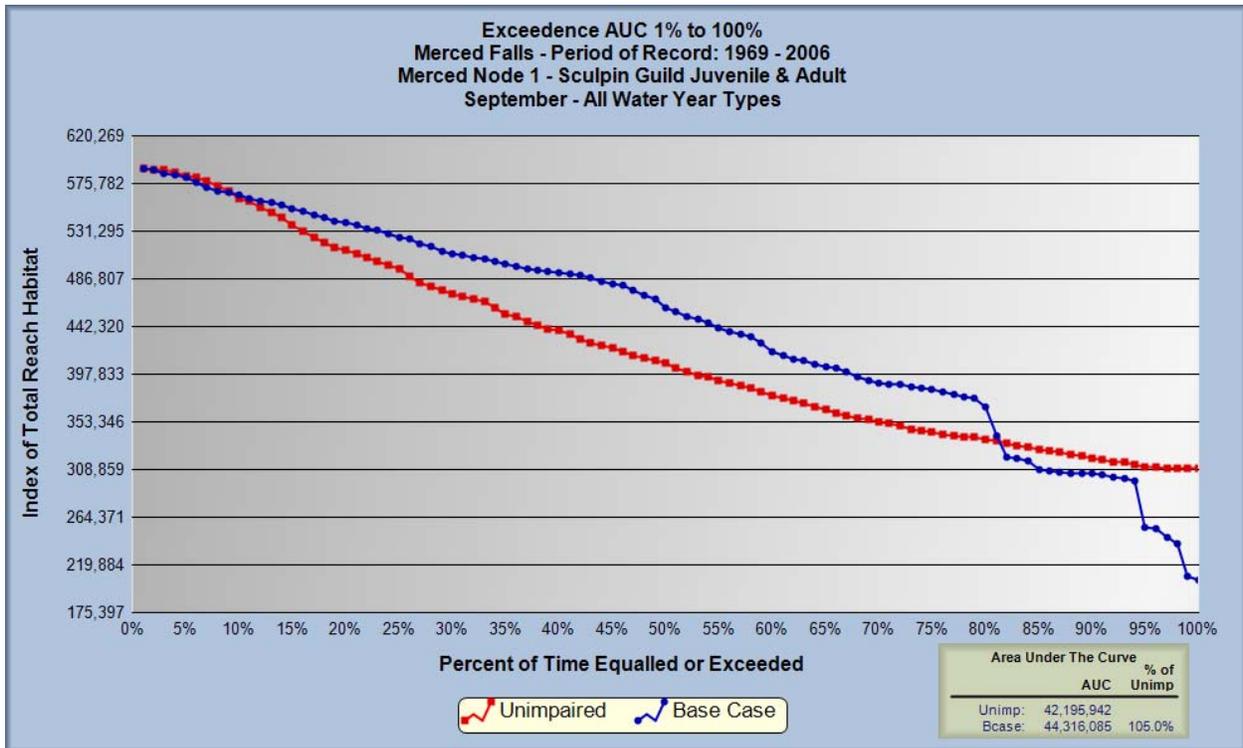


Figure 3.1-85. Habitat exceedance for sculpin guild (juvenile and adult) in September.

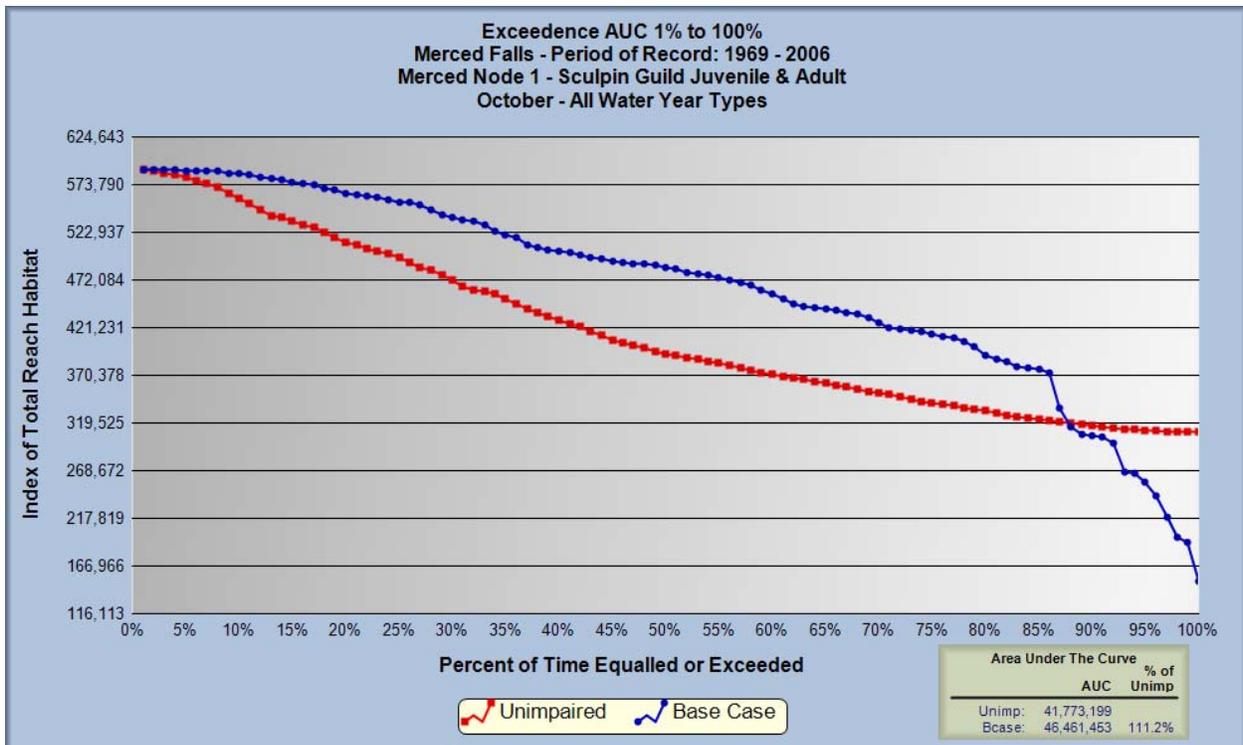


Figure 3.1-86. Habitat exceedance for sculpin guild (juvenile and adult) in October.

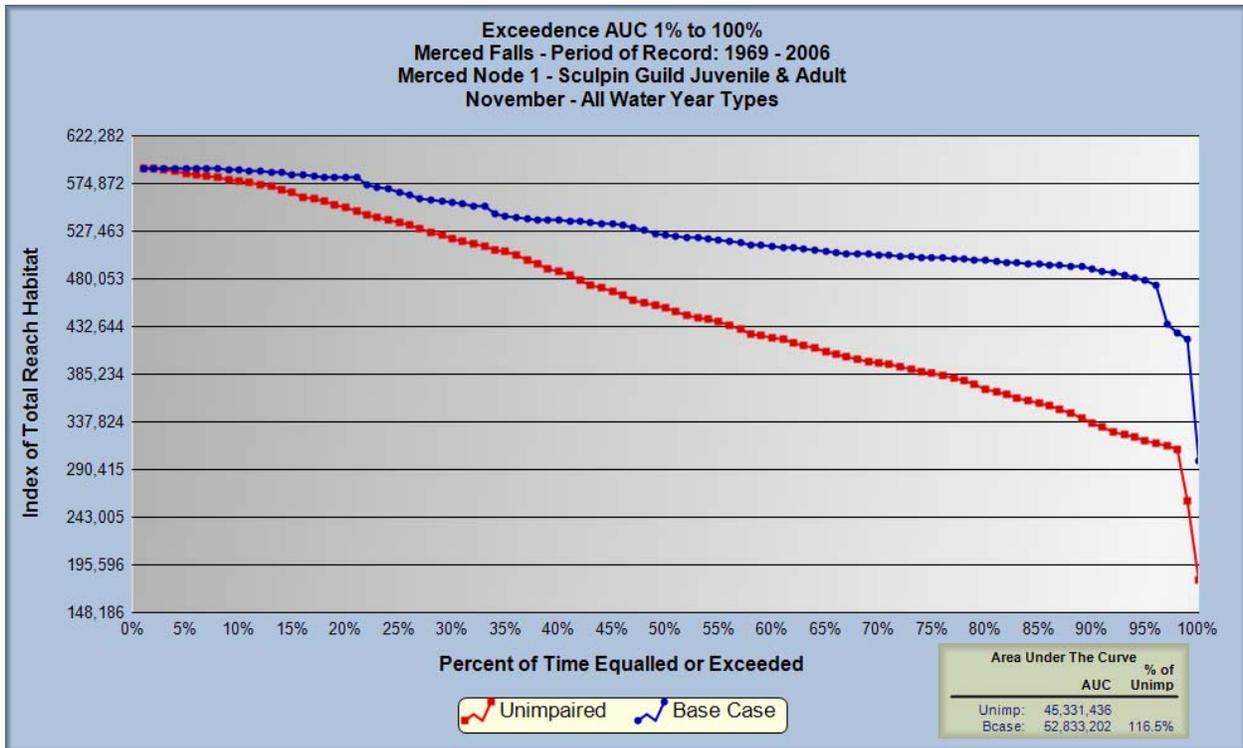


Figure 3.1-87. Habitat exceedance for sculpin guild (juvenile and adult) in November.

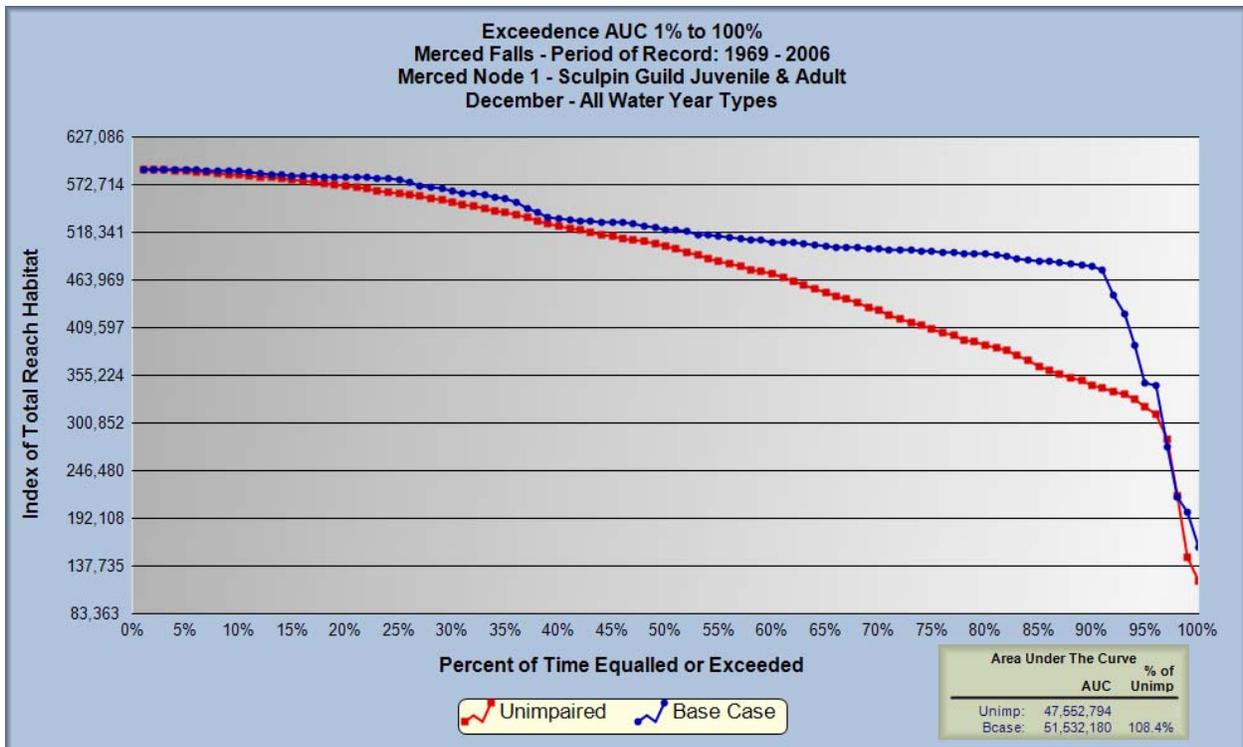


Figure 3.1-88. Habitat exceedance for sculpin guild (juvenile and adult) in December.

3.1.2 Merced Falls – Impoundment sub-reach

Habitat index curves (WUA) for the impoundment sub-reach are shown in Table 3.2-1 and Table 3.2-2 and in Figure 3.2-1 and Figure 3.2-2. This sub-reach displays an atypical suitability curve trends for many life stages in which suitability is relatively flat as flows increase. Rainbow trout adult, rainbow trout juvenile, lamprey ammocoete, and the sculpin guild are the exceptions, exhibiting a gradual peak in the habitat index. At approximately 3,000 cfs, water levels rise above the banks in the lower portion of the impoundment thus recruiting additional low velocity, shallow habitat. As a result, habitat continues to increase at high flows for rainbow trout spawning and juvenile, lamprey ammocoete and Sacramento sucker juvenile lifestages. The observed increase in habitat may be an artifact and limitation of the model in which modeled low velocities along the stream margin are unrealistically propagated as flows increase.

Table 3.2-1 WUA results for rainbow trout lifestages in the Impoundment sub-reach.

Discharge	Spawning	Fry	Juvenile	Adult
194	50	5,817	47,323	34,383
250	60	5,789	48,176	39,736
300	72	5,780	48,937	44,643
350	82	5,767	49,622	49,445
400	94	5,763	50,305	54,235
450	103	5,748	50,854	59,013
500	112	5,737	51,351	63,870
550	123	5,725	51,812	68,654
600	131	5,706	52,154	73,244
700	146	5,670	52,667	81,462
800	162	5,624	52,927	88,403
900	175	5,584	52,935	93,929
1,000	186	5,544	52,757	98,002
1,100	195	5,492	52,369	100,772
1,200	198	5,434	51,782	102,369
1,300	204	5,380	51,132	102,793
1,400	203	5,308	50,390	102,408
1,500	199	5,246	49,552	101,256
1,750	190	5,083	47,385	96,711
2,000	175	4,907	45,168	91,444
2,250	106	4,718	43,081	87,443
2,500	50	4,470	41,132	84,052
2,750	26	4,313	39,277	80,755
3,000	16	4,233	37,465	77,485
3,500	5	5,425	34,998	71,657
4,000	1	5,926	35,181	66,095
4,500	3	6,511	35,609	61,925
5,000	3	7,001	36,846	58,703
5,500	6	7,306	38,550	56,407
5,810	7	7,427	39,302	55,448

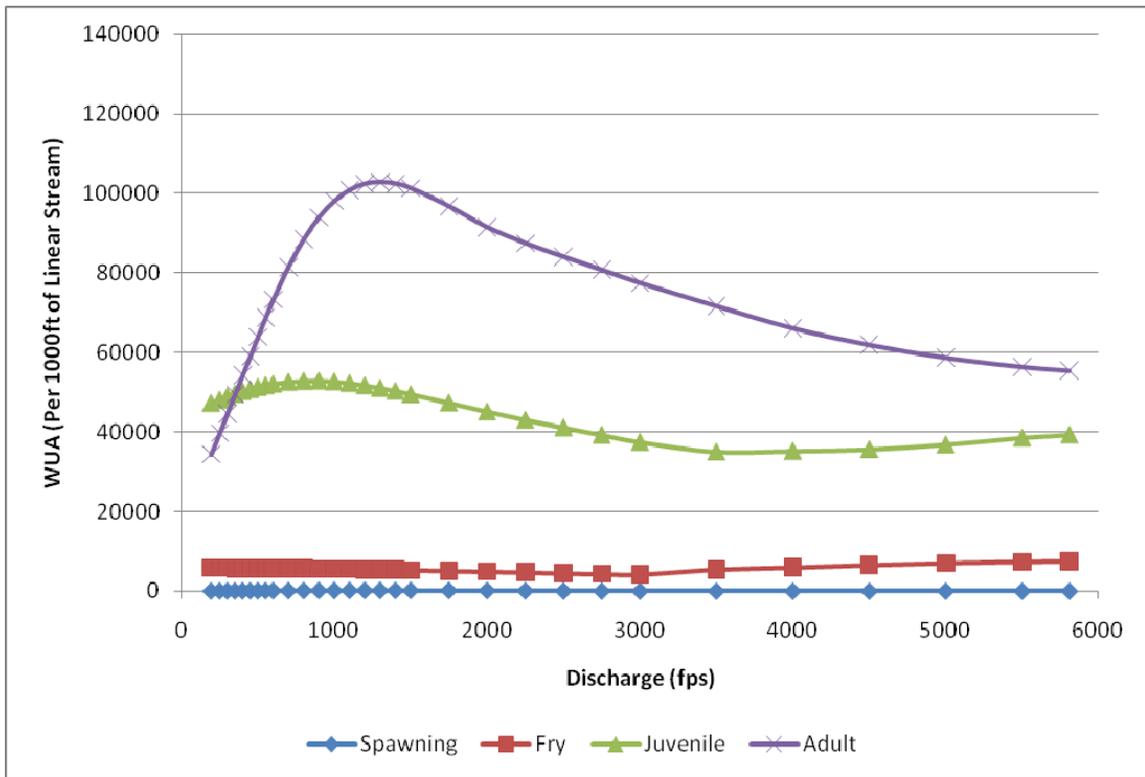


Figure 3.2-1. Modeled habitat suitability index (WUA) for rainbow trout, in the Impoundment sub-reach below Merced Falls Dam.

Table 3.2-2. WUA results for lamprey, Sacramento sucker and sculpin guild in the Impoundment sub-reach.

Discharge (cfs)	Lamprey Guild Ammocoete	Lamprey Guild Spawning	Sacramento Sucker Juvenile	Sacramento Sucker Adult	Sculpin Guild Juvenile & Adult
194	123,690	1,378	22,581	40,328	40,326
250	119,473	1,760	21,623	40,161	42,121
300	113,448	2,111	21,456	40,161	43,715
350	108,485	2,456	21,456	40,140	45,260
400	104,435	2,800	21,539	40,265	46,768
450	101,412	3,110	21,539	40,161	48,202
500	9,820	3,394	21,435	40,161	49,571
550	95,074	3,639	21,372	40,161	50,873
600	91,687	3,838	21,372	40,161	52,077
700	85,184	4,155	21,456	40,328	54,259
800	79,059	4,381	21,456	40,494	56,181
900	74,014	4,524	21,664	40,328	57,807
1,000	70,836	4,601	22,289	40,156	59,169
1,100	67,655	4,613	21,685	39,474	60,297
1,200	65,157	4,579	20,498	38,578	61,203
1,300	62,746	4,540	20,717	37,700	61,921
1,400	60,177	4,487	20,540	35,746	62,437
1,500	58,160	4,422	19,273	35,552	62,801
1,750	52,628	4,224	19,399	34,308	63,102
2,000	49,896	3,935	19,399	32,653	62,667
2,250	47,178	3,528	19,232	30,765	61,842

Table 3.2-2. (continued)

Discharge (cfs)	Lamprey Guild Ammocoete	Lamprey Guild Spawning	Sacramento Sucker Juvenile	Sacramento Sucker Adult	Sculpin Guild Juvenile & Adult
2,500	45,132	3,121	18,733	28,802	60,773
2,750	43,581	2,766	18,466	28,460	59,606
3,000	47,066	2,488	16,371	26,167	58,469
3,500	48,900	2,055	16,782	22,857	56,529
4,000	48,436	1,736	20,660	22,066	53,906
4,500	46,592	1,496	27,920	20,757	51,341
5,000	45,013	1,312	29,337	17,668	48,832
5,500	43,658	1,172	30,318	17,050	46,428
5,810	42,105	1,104	30,976	18,001	45,055

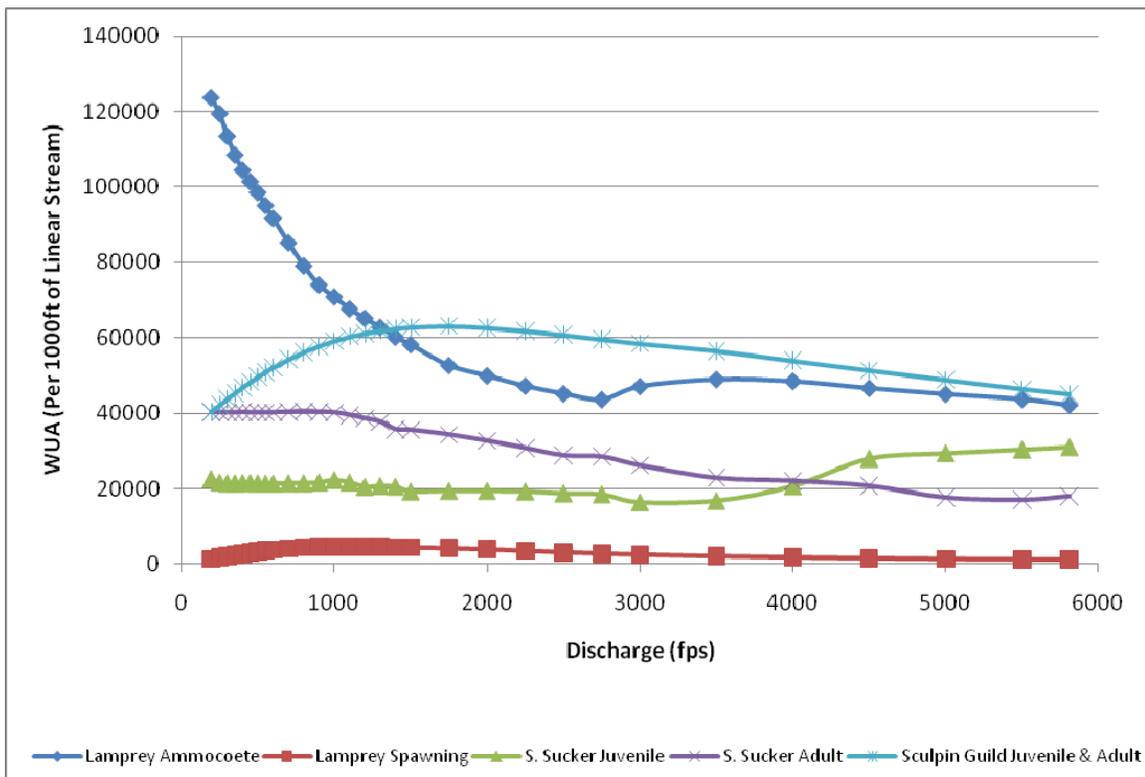


Figure 3.2-2. Modeled habitat suitability index (WUA) for, Sacramento sucker and sculpin guild, in the Impoundment sub-reach below Merced Falls Dam.

4.0 Discussion

It is important for those interested in the analysis phase of the instream flow study to recognize that the end result of an instream flow study is not a set value or values but models of simulated ranges of values. These models are used as tools, in concert with other analytical tools and information, to evaluate the effect of alternative stream flows on project operations and fish and aquatic habitat. Discussions of specific results are therefore a part of, and the product of, flow-related resource measures development discussions between Merced ID and Relicensing

Participants. However, a brief summary of the results for each sub-reach will provide the foundation for future discussions.

4.1 Riverine Sub-reach

As described in Section 2.2.6.3 above, the available physical habitat or WUA, is defined as the sum of stream surface area within a reach or sub-reach, weighted by multiplying area by habitat suitability variables, most often velocity, depth, and substrate or cover, which range from 0.0 to 1.0 each, normalized to square units (either in feet or meters) per 1,000 linear units. WUA does not translate to actual area of suitable habitat but indicates the relative suitability of the available habitat.

Peak WUA values for all species/guilds and lifestages in the riverine sub-reach range from a minimum value of 100 cfs (lamprey ammocete) to maximum value of 500 cfs (sculpin guild). Unlike the other species of interest, rainbow trout fry exhibit a strong bi-modal WUA function where WUA rises above the initial peak at the highest simulated flows. The first WUA peak on this curve is observed at 200 cfs while the second is observed at the highest simulation flow of 8000 cfs. The rise in habitat at the highest flows is likely due to a combination of flow overtopping low banks at certain transects, thereby recruiting new habitat, and/or an artifact and limitation of the model in which modeled low velocities along the stream margin are unrealistically propagated as flows increase. The mean WUA value for all species (excluding rainbow trout fry) in this reach is 272 cfs.

It is often of interest to identify a range of WUA values that are greater than 80 percent of the maximum value on the WUA curve for each species/guild of interest. These WUA values for all species/guilds and lifestages in the riverine sub-reach range from a minimum value of 100 cfs (rainbow trout fry, lamprey ammocete, lamprey spawning and Sacramento sucker) to a maximum value of 1,240 cfs (sculpin guild). Due to the bi-modal peak of the rainbow trout fry curve, WUA values above 80 percent are also found above 6,000 cfs.

As described above in Section 3.1.1, a total of 1,040 habitat exceedance charts would be generated if all species/lifestages (9), water year types (5), months (12), nodes (2) were analyzed and provided in this Technical Memorandum. It is therefore not feasible to provide a detailed description of each habitat exceedance chart provided in this technical memorandum or every chart possible using the Habitat Analysis Tool.

The interactive Habitat Analysis Tool, available to all interested Relicensing Participants enables users to view WUA, hydrology data sets, habitat time series and generate habitat duration graphs and tables of any combination of species/lifestage, month, water year type, or hydrology set for the riverine sub-reach of the Merced Falls Dam study reach.

To gain an understanding of the habitat duration results provided both in tabular and graphical form, reviewers are encouraged to review Section 2.2.7 for a detailed review of how habitat exceedance curves are developed.

4.2 Impoundment Sub-reach

Habitat suitability indices for the species modeled in the impoundment are a-typical and relatively flat. This response is due to the stable stage (small water stage fluctuation) and moderate velocity increases per unit discharge increase. That is, WUA is primarily driven by depth in much of the impoundment. For the spawning lifestages, lack of suitable substrate limits habitat suitability. Peak WUA values for all species/guilds and lifestages modeled in the impoundment sub-reach range from a minimum value of 100 cfs (lamprey ammocete) to maximum value of 2,000 cfs (sculpin guild). Though generally flat, both rainbow trout fry and Sacramento sucker both exhibit a rise in the WUA function where peak habitat is not achieved until the highest simulated flow which in this sub-reach was 5,810 cfs. The upward trend in habitat is likely due to a combination of flow overtopping low banks at certain transects, thereby recruiting new habitat, and/or an artifact and limitation of the model in which modeled low velocities along the stream margin are unrealistically propagated as flows increase. The mean WUA value for all species (excluding rainbow trout fry and Sacramento sucker) in this reach is 1,049 cfs.

WUA values greater than 80 percent of the maximum on the WUA curve for each species/guild modeled in the impoundment sub-reach range from a minimum value of 100 cfs (rainbow trout juvenile, lamprey ammocete and Sacramento sucker) to a maximum value of 4,500 cfs (sculpin guild). Due to the upward trend of the rainbow trout fry and Sacramento sucker curves, values above 80 percent are also found from 4,500 cfs to 5,810 cfs.

5.0 Study-Specific Consultation

The FERC-approved study required Merced ID to perform the following study-specific consultation:

5.1 **Coordinate and Cooperate with PG&E During Study Plan Development**

The Director's decisions stated:

Such a study will necessitate cooperation between MID and PG&E. Therefore, we will require MID, in coordination with PG&E, to file a flow-habitat study plan for resident fish and Pacific lamprey between Merced Falls dam and Crocker-Huffman.

Mr. Geoff Rabone, of Merced ID spoke with Mr. Steve Nevares, of PG&E, on January 4, 2010, to initiate coordination between Merced ID and PG&E regarding the Instream Flow Study for the Merced River between PG&E's Merced Falls Dam and Crocker-Huffman Diversion Dam. Rabone and Nevares spoke again on January 6 and 7, 2010. Mr. Nevares advised Mr. Rabone that PG&E would cooperate with Merced ID to provide adequate flow and access for Merced ID to perform the study. Mr. Nevares advised Mr. Rabone that PG&E did not need to review the study plan.

5.2 Consult with NMFS, USFWS and SWRCB During Study Plan Development

The Director's decisions stated:

Within 45 days of the date of this letter, and after consultation with NMFS, FWS, and the Water Board, MID should file, for Commission approval, plans for the implementation of these studies.

Merced ID called representatives of the NMFS, USFWS and SWRCB on January 4, 2010, and provided them early notice that Merced ID planned to transmit by e-mail to each of them a draft Instream Flow Study Plan around January 8, 2010, for review and comment, and that Merced ID requested written comments no later than 2 weeks after receipt of the draft study plan. Merced ID also offered to coordinate a visit to the reach, or otherwise facilitate review and comment by each agency.

On January 11, 2010, Merced ID transmitted via e-mail to NMFS, USFWS, and SWRCB each a draft Instream Flow Study Plan reiterating that Merced ID requested written comments no later than close of business on January 26, 2010, 2 weeks after transmittal of the draft study plan. Merced ID followed transmittal of the e-mail with a phone call to each agency to advise them that the study plan had been e-mailed to them.

Merced ID received written comments on its draft Instream Flow Study Plan from the SWRCB in a letter dated January 26, 2010 and from USFWS in a letter dated January 26, 2010. Written comments were not received from NMFS. Merced ID replied to both the SWRCB's and USFWS's comment letters on February 5, 2010.

5.3 Consult with Relicensing Participants Regarding Lamprey Guild HSC and Periodicity

The Director's decisions stated:

Licensee will invite NMFS, USFWS and SWRCB staff to consult with Licensee's fishery biologists regarding appropriate lamprey life stages and the development of Category I, binary [Habitat Suitability Criteria] HSC for lamprey life stages. Category I are HSC developed using the professional judgment of knowledgeable fishery scientists when data for higher level category HSCs (i.e., Categories II and III) are unavailable (Bovee 1978).

In consultation with Relicensing Participants who included the NMFS, USFWS, and SWRCB, Merced ID scheduled and held a meeting at the Holiday Inn in Merced, California to collaboratively develop lamprey Category I HSC. Held on June 24, 2010, the meeting attendees included representatives from NMFS, USFWS, SWRCB, CDFG, non-governmental organizations, and Merced ID. A letter advising FERC of Merced ID's collaboration regarding development of lamprey HSC was filed on July 23, 2010.

Meeting participants reviewed existing and relevant information regarding lamprey and Pacific lamprey HSC. Only two sources were identified and both focused on the ammocoete life stage: Close et al. (2002)⁹ and Gard (2009).¹⁰ Meeting participants were not aware of existing HSC for Kern Brook lamprey or brook lamprey of any species. Meeting participants concluded Close et al. (2002) included the most robust data set that could be used to generate lamprey HSC. As a result, Close et al. was used as the basis for development of the lamprey ammocoete HSC, while Gard (2009) was used to support the development. Close et al. (2002) identified six suitability indices including substrate type, current velocity, depth of organic matter, habitat type, channel type, and channel location. Meeting participants agreed to use the suitability indices of substrate and current velocity as described by Close et al. (2002). Meeting participants included water depth to conservatively represent channel type, habitat type, and channel location. Meeting participants agreed that any organic debris would be assumed to be sufficient for habitat suitability and, therefore, depth of organic debris was not included. The resulting collaboratively developed HSC for the lamprey ammocoete life stage are shown in Table 5.3-1.

Table 5.3-1. Lamprey HSC for ammocoete lifestage.

Lifestage	Velocity (cm/sec)	Suitability	Depth (ft)	Suitability	Substrate Code	Suitability
Ammocoete	0-4	1.00	wet	1.00	organic debris	0.22
	5-9	0.83	not wet	0.00	Silt	1.00
	10-19	0.38	--	--	sand	0.54
	20-29	0.09	--	--	small gravel	0.15
	30-39	0.00	--	--	large gravel	0.05
	40-49	0.00	--	--	Cobble	0.06
	>49	0.04	--	--	Boulder	0.05
	--	--	--	--	bed rock	0.22

Meeting participants also developed HSC for the adult spawning lifestage of lamprey using data from Gunckel et al. (2009).¹¹ Habitat suitability was conservatively categorized using presence/absence. This approach assumes that the habitat type in which spawning adult lamprey were observed by Gunckel et al. (2009) is suitable habitat in the Merced River between Merced Falls Dam and Crocker-Huffman Diversion Dam. To be more conservative in the water depth suitability index, exceeding the maximum depth described by Gunckel et al. (2009) was not considered an absence of suitable spawning habitat (i.e., suitability of 0), but was rather characterized as lower likelihood of suitable habitat and, therefore, assigned a suitability of 0.1. The resulting collaboratively developed HSC for the lamprey adult spawning life stage are shown in Table 5.3-2.

⁹ Close, David, Kimmo Aronsuu, Aaron Jackson, T. Robinson, Jennifer Bayer, James Seelye, Sang-Seon Yun, Alexander Scott, Weiming Li, Christian Torgersen. 2002. Pacific Lamprey Research and Restoration Project. Project No. 1994-02600, 115 electronic pages, (BPA Report DOE/BP-00005455-6).

¹⁰ Gard, Mark. 2009. Demonstration flow assessment and 2-D modeling: perspectives based on instream flow studies and evaluation of restoration projects. Fisheries, 34 (7): 320-329, July 2009.

¹¹ Gunckel, Stephanie L., Kim K. Jones, and Steven E. Jacobs. 2009. Spawning distribution and habitat use of adult Pacific and western brook lampreys in Smith River, Oregon. American Fisheries Society Symposium, 72: 173-189, 2009.

Table 5.3-2. Lamprey HSC for spawning lifestage.

Lifestage	Velocity (cm/sec)	Suitability	Depth (cm)	Suitability	Substrate Code	Suitability
Spawning	<20	0.00	< 16	0.00	organic Debris	0.00
	20-100	1.00	16-128	1.00	Silt	0.00
	>100	0.00	> 129	0.10	Sand	0.00
	--	--	--	--	small gravel	1.00
	--	--	--	--	large gravel	1.00
	--	--	--	--	small cobble	0.00
	--	--	--	--	large cobble	0.00
	--	--	--	--	Boulder	0.00
--	--	--	--	bed rock	0.00	

Meeting participants agreed that HSC for the juvenile out-migrant, egg incubation, and adult pre-spawning lifestages of lamprey would not be developed, and these life stages would not be modeled in the study.

5.4 Consult with Relicensing Participants Regarding Transect Placement

Merced ID invited interested and available Relicensing Participants to review instream flow transects on February 24, 2010. Representatives from CDFG, USFWS, PG&E, Merced ID, GANDA, HDR|DTA, and the Merced River Conservation Committee were present. Merced ID had a narrow time window in which to gather low flow data in the section of river from Merced Falls Dam to Crocker-Huffman Diversion Dam because flows were expected to increase from about 250 cfs to over 300 cfs on March 1 and to 800 cfs by March 15, 2010. Flows would not be as low as 250 cfs again until late October 2010. To diligently perform the study and avoid a year delay, Merced ID proceeded with data collection immediately after transect selection.

A subsequent transect placement field visit was scheduled on March 17, 2010 giving Relicensing Participants an additional date to review and comment on the location of Instream Flow transects. Representatives from CDFG, USFWS, SWRCB, GANDA, HDR|DTA, and the Merced River Conservation Committee were present. No adjustments of transect locations were suggested, nor were there any additional recommendations for modification.

5.5 Consult with USFWS Regarding Rainbow Trout Substrate HSC

In the development of WUA for the reach below Merced Falls Dam, Licensee used rainbow trout HSC recommended by USFWS in USFWS's January 26, 2010 letter to Merced ID. These include USFWS (2004) for adult and juvenile rainbow trout, and USFWS (2008) for fry rainbow trout. The HSC provided did not include substrate as habitat criteria and thus was not included as a component of WUA.

For rainbow trout spawning, Licensee used recently developed curves for use in large rivers (i.e., widths >150 feet) in Nevada Irrigation District's Yuba-Bear Hydroelectric Project (FERC Project No. 2266) and PG&E's Drum-Spaulding Project (FERC Project No. 2310). Both of the relicensings are on the Yuba and Bear rivers in California. This curve included substrate as a

habitat criterion. Note that participants in those relicensings decided that substrate was not an important factor in habitat preference for fry, juvenile and adult life stages, and was not used in those relicensings.

5.6 Consult with Relicensing Participants Regarding PHABSIM and HEC-RAS Hydraulic Models

Merced ID consulted with interested and available Relicensing Participants regarding Merced ID's calibration of the PHABSIM hydraulic model on January 7, 2011. Merced ID posted on its Relicensing Website the PHABSIM hydraulic modeling calibration report for the Riverine sub-reach, and notified Relicensing Participants via e-mail that the material was available on the Website on December 14, 2010. Also made available to participating Relicensing Participants was the preliminary HEC-RAS impoundment sub-reach hydraulic model.

On February 16, 2011 Merced ID continued discussion and consultation with interested and available Relicensing Participants regarding Merced ID's calibration of the HEC-RAS impoundment sub-reach hydraulic model.

6.0 Variations from FERC-Approved Study

There were two variations to the FERC-approved study. First, Merced ID is slightly behind the anticipated study completion date of September-October 2010 as outlined in Section 6.0 of the study plan due to delayed data collection. Merced ID attempted to collect substrate and cover data during each site visit. During low flow conditions in February and March of 2010, snowmelt run-off and rain events increased turbidity thereby limiting substrate visibility. High volume flows for the remainder of the year precluded substrate and cover data collection on most transects. All remaining substrate and cover data were collected in mid-November 2011.

Second, during the February 16, 2011 conference call, Relicensing Participants agreed to run WUA in the impoundment sub-reach but that it was unnecessary to run the habitat duration analysis.

7.0 Attachments to this Technical Memorandum

This technical Memorandum includes 6 attachments:

- Attachment 3-4A PHABSIM Transect Photos – Low Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 3.8MB; 30 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4B PHABSIM Transect Photos - Mid Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 7.2MB; 36 pages formatted to print double sided on 8 ½ x 11 paper]

- Attachment 3-4C PHABSIM Transect Photos - High Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 13.7MB; 58 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4D PHABSIM Transect Photos – High High Flow - Merced River Hydroelectric Project [1 Adobe pdf file: 9.7MB; 48 pages formatted to print double sided on 8 ½ x 11 paper]
- Attachment 3-4E Part 1 - PHABSIM Riverine sub-reach hydraulic model calibration reports [1 Adobe pdf file: 9.7MB; 48 pages formatted to print double sided on 8 ½ x 11 paper]
Part 2 – HEC-RAS Impoundment sub-reach hydraulic model [1 Adobe pdf file: 355 kB; 11 pages formatted to print double sided on 8 ½ x 11 paper, 9 pages formatted to print single sided on 11 x 17.]
- Attachment 3-4F Habitat Analytical Tool for the Merced River Below Merced Falls [Available on DVD]

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