

**Figure 5.2-22. Instream cover complexity in the lower Feather River from Bear River to the confluence with the Sacramento River.**

## 5.2.5 Water temperature

### 5.2.5.1 Data Summary

Water temperatures were recorded at 24 thermograph locations within the lower Feather River approximately every fifteen minutes between January 2003 and December 2003. The mean daily water temperature was calculated for each day during which data were available. The lowest and highest recorded mean daily temperatures were 45.5°F (7.5°C) and 75.9°F (24.4°C), respectively. Water temperatures ranged from 45.5°F to 51.1°F (7.5°C to 10.6°C) in winter, and from 60.6°F to 75.9°F (15.9°C to 24.4°C) in summer. Table 5.2-5 summarizes the information collected by the data loggers.

**Table 5.2-5. Mean daily water temperature data in the Feather River from January 2002 to December 2003.**

Logger Name	River Mile	Lowest Mean Daily Temperature (°F)	Highest Mean Daily Temperature (°F)
DS from Diversion Dam	67.4	47.4	61.0
A Oroville	67.0	46.9	60.6
US from Hatchery	66.6	47.1	61.0
Aerator Outfall	66.4	46.8	60.6
Hatchery Setting Pond	66.4	46.9	61.5
A Auditorium	66.2	46.9	61.1
Spawning Channel	66.2	45.5	63.4
DS from Hatchery	66.0	47.3	61.3
DS from Hwy 162	64.1	51.1	62.6
A Robinson Riffle	61.7	46.5	65.5
A Eye Riffle	60.2	46.0	66.5
US from Afterbay outlet	59.4	46.3	67.4
US from SCOR outlet	58.8	46.4	70.2
DS from SCOR outlet	58.7	46.4	68.8
DS from Afterbay	58.6	46.4	70.7
NR Mile Long Pond	57.3	46.1	70.7
DS from Project Boundary	53.5	46.5	71.1
A Singh AB Riviera Road	45.9	46.7	72.1
A Archer Ave	41.8	46.7	72.4
US from Yuba R	28.2	45.9	75.9
A Shangai Bend	25.2	46.0	73.3
A Star Bend	18.2	46.2	72.3
A Nicolaus	9.3	45.8	74.3
NR Verona	0.3	46.1	74.7

Between the Thermalito Diversion Dam and the Thermalito Afterbay Outlet, four water temperature loggers were selected for use in the characterization of the seasonal water temperature ranges within the reach. The loggers were named “A Oroville,” “DS from hatchery,” “A Robinson Riffle,” and “US from Afterbay Outlet” (Figure 5.2-23). Based on

data obtained from these four water temperature loggers, mean daily water temperatures within the reach ranged from 45.5°F to 67.4°F (7.5°C to 19.7°C) between January 2002 and December 2003.

Between the Thermalito Afterbay Outlet and Honcut Creek, three water temperature loggers were selected for use in the characterization of the seasonal water temperature ranges of the reach. The loggers were named “US from SCOR Outlet,” “DS from Project Boundary,” and “A Singh AB Riviera Rd” (Figure 5.2-24). Based on data obtained from these three water temperature loggers, mean daily water temperatures within the reach ranged from 46.1°F to 76.1°F (7.8°C to 24.5°C) between January 2002 and December 2003. Between Honcut Creek and the Yuba River, two water temperature loggers were selected for use in the characterization of the seasonal water temperature ranges of the reach. The loggers were named “A Archer Ave” and “US from Yuba River” (Figure 5.2-25). Based on water temperature data from these two water temperature loggers, mean water temperatures within the reach ranged from 45.9°F to 75.9°F (7.7°C to 24.4°C) between January 2002 and December 2003.

Between the Yuba River and the Bear River, two water temperature loggers were selected for use in the characterization of the seasonal water temperature ranges of the reach. The loggers were named “A Shanghai Bend” and “A Star Bend” (Figure 5.2-26). Based on water temperature data obtained from these two water temperature loggers, mean water temperatures within the reach ranged from 46°F to 76.3°F (7.8°C to 22.9°C) between January 2002 and December 2003. Between the Bear River and the confluence of the Feather and Sacramento rivers, two water temperature loggers were selected for use in the characterization of the seasonal water temperature ranges of the reach. The loggers were named “A Nicolaus” and “NR Verona” (Figure 5.2-27). Based on water temperature data obtained from these two water temperature loggers, mean water temperatures within the reach ranged from 45.8°F to 74.7°F (7.7°C to 23.7°C) between January 2002 and December 2003.

### **5.2.5.2 Data Limitations**

Although the differentially corrected GPS location of the water temperature loggers are within plus or minus 1-meter spatial precision, the water temperatures obtained from each logger represented only that point location at the bottom of the water column where the water temperature logger was located. Monthly and bi-monthly samples of water temperatures at ½-meter depth intervals, in sixteen locations, over a 16-month period, have shown that the water temperatures do not stratify in the those pools within the lower Feather River. Based on those data, it was assumed that no water temperature stratification occurred within the lower Feather River in 2003. The Final Report for SP-F10 Task 1D and Task 1E (DWR 2004c) provides detailed analysis of the water temperature profiles with respect to water temperature stratification within pools in the lower Feather River.

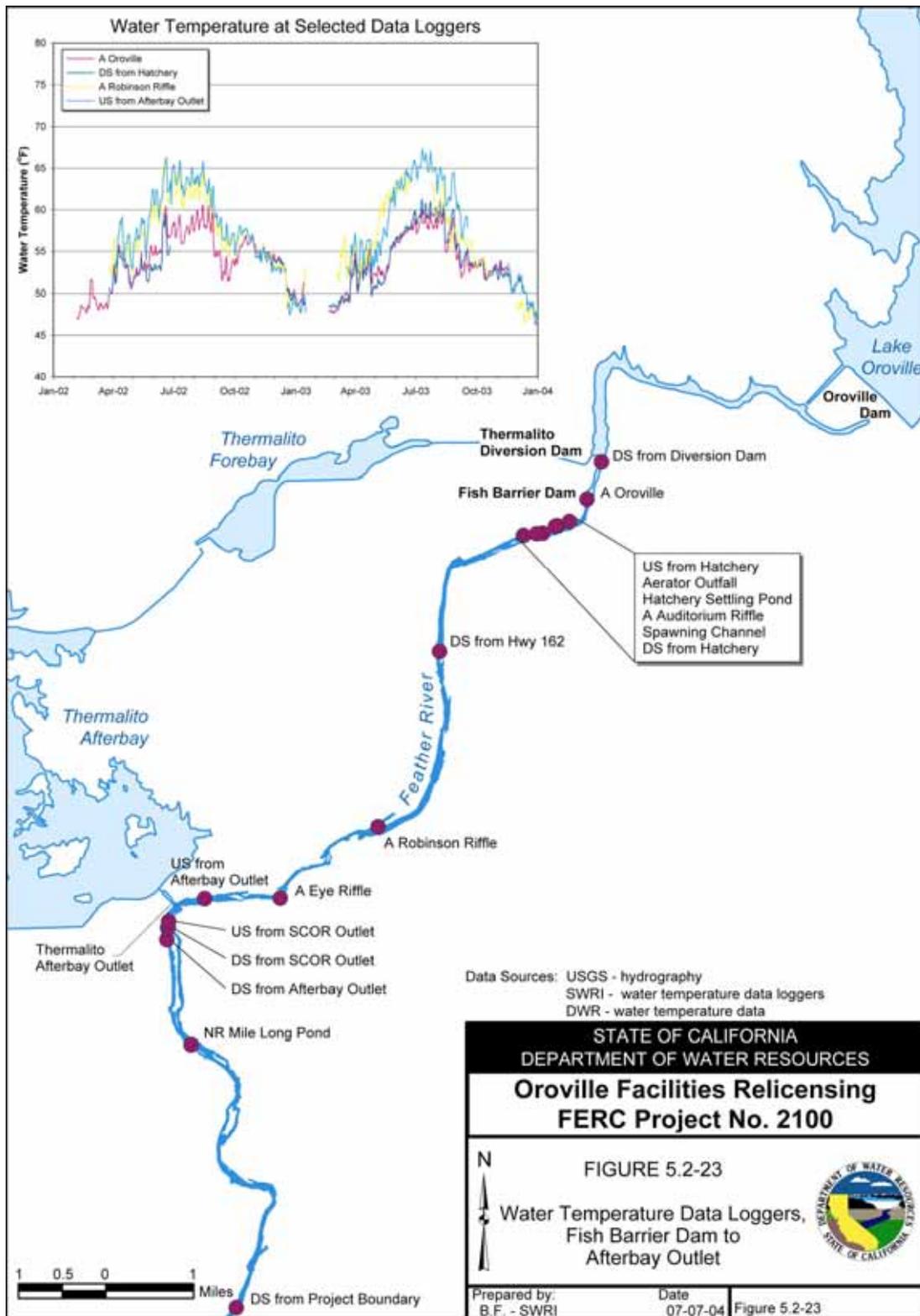


Figure 5.2-23. Water Temperature logger locations with selected logger time series graphs from Fish Barrier Dam to Afterbay Outlet.

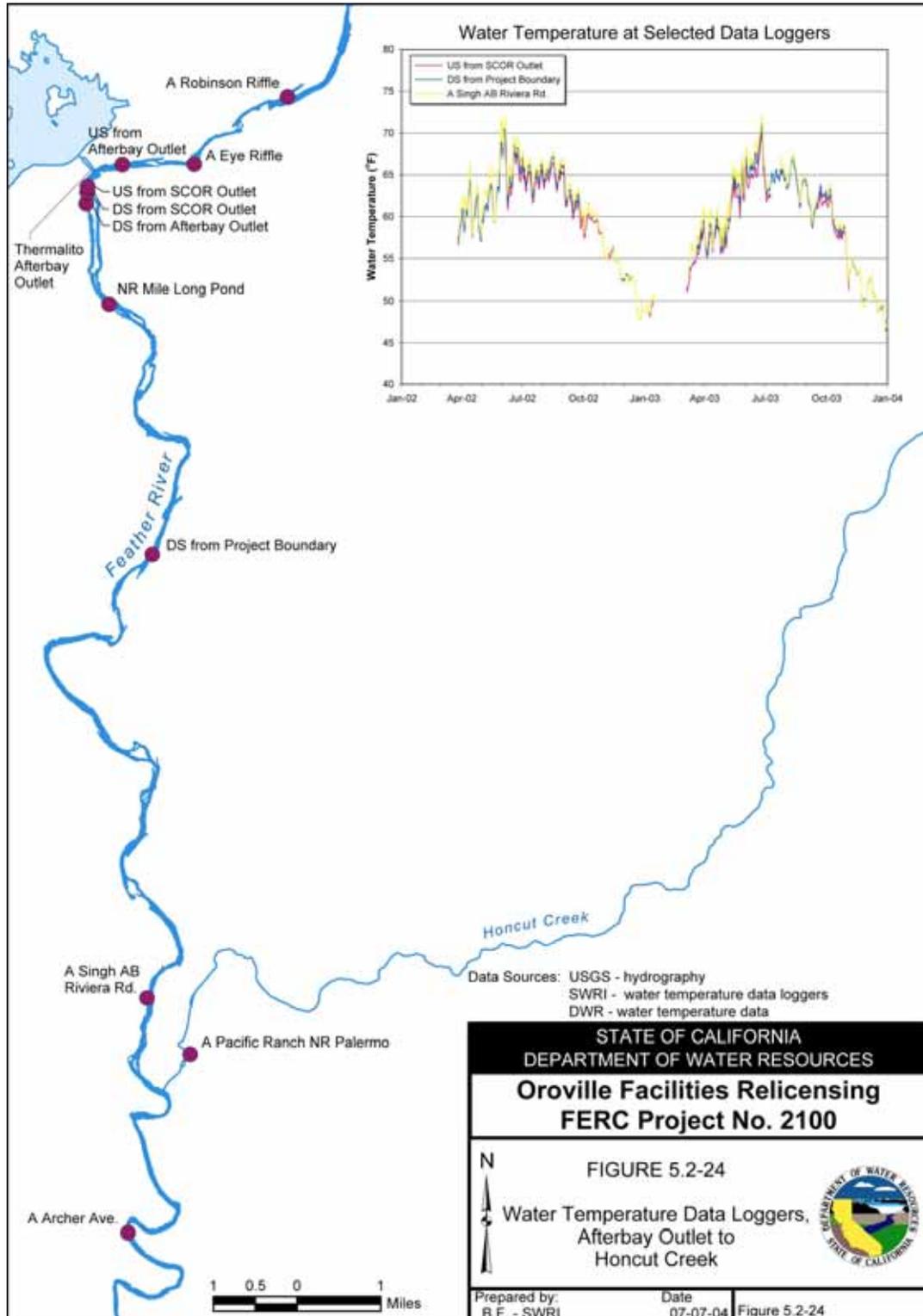


Figure 5.2-24. Water Temperature logger locations with selected logger time series graphs from Afterbay Outlet to Honcut Creek.

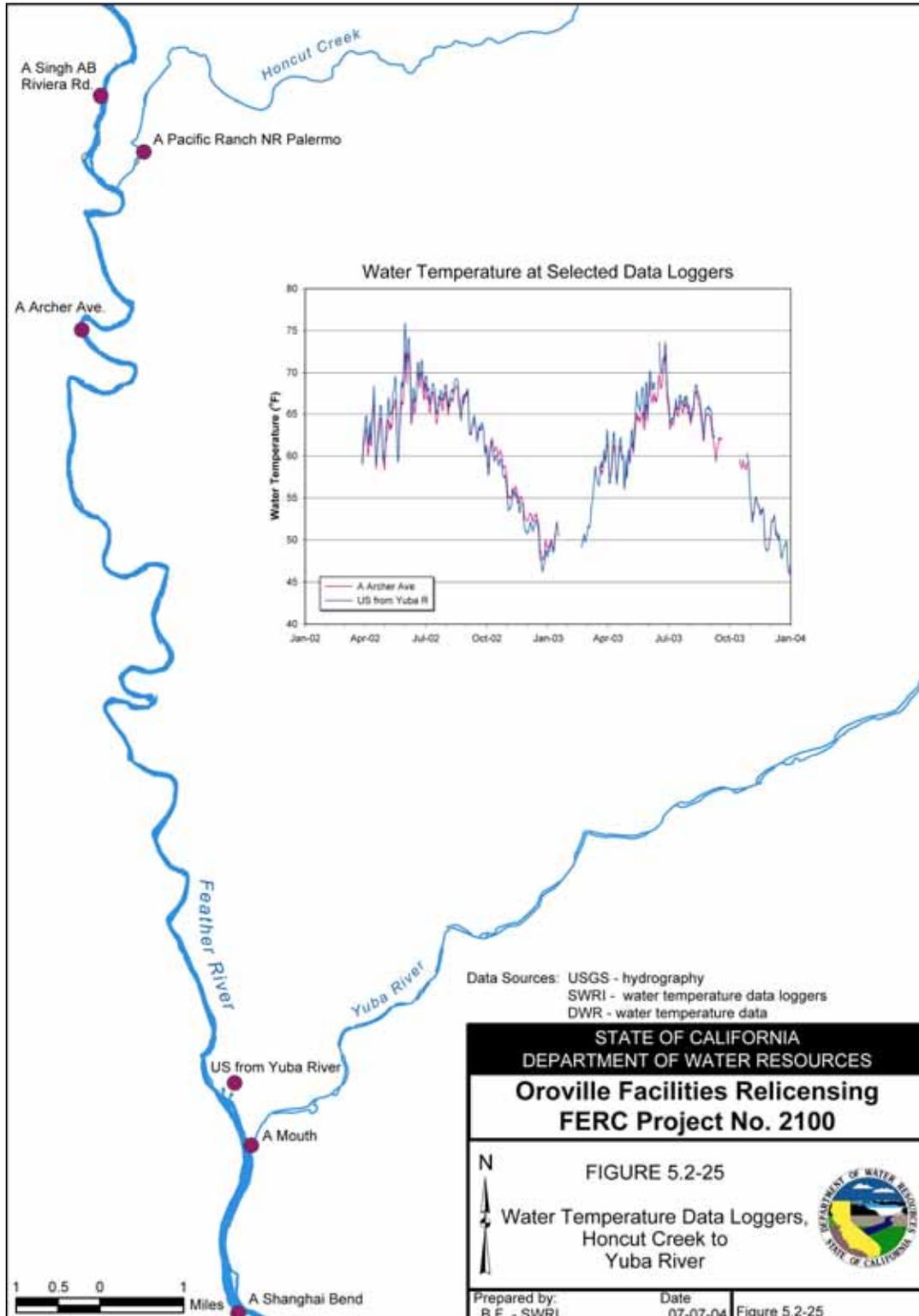


Figure 5.2-25. Water Temperature logger locations with selected logger time series graphs from Honcut Creek to Yuba River.

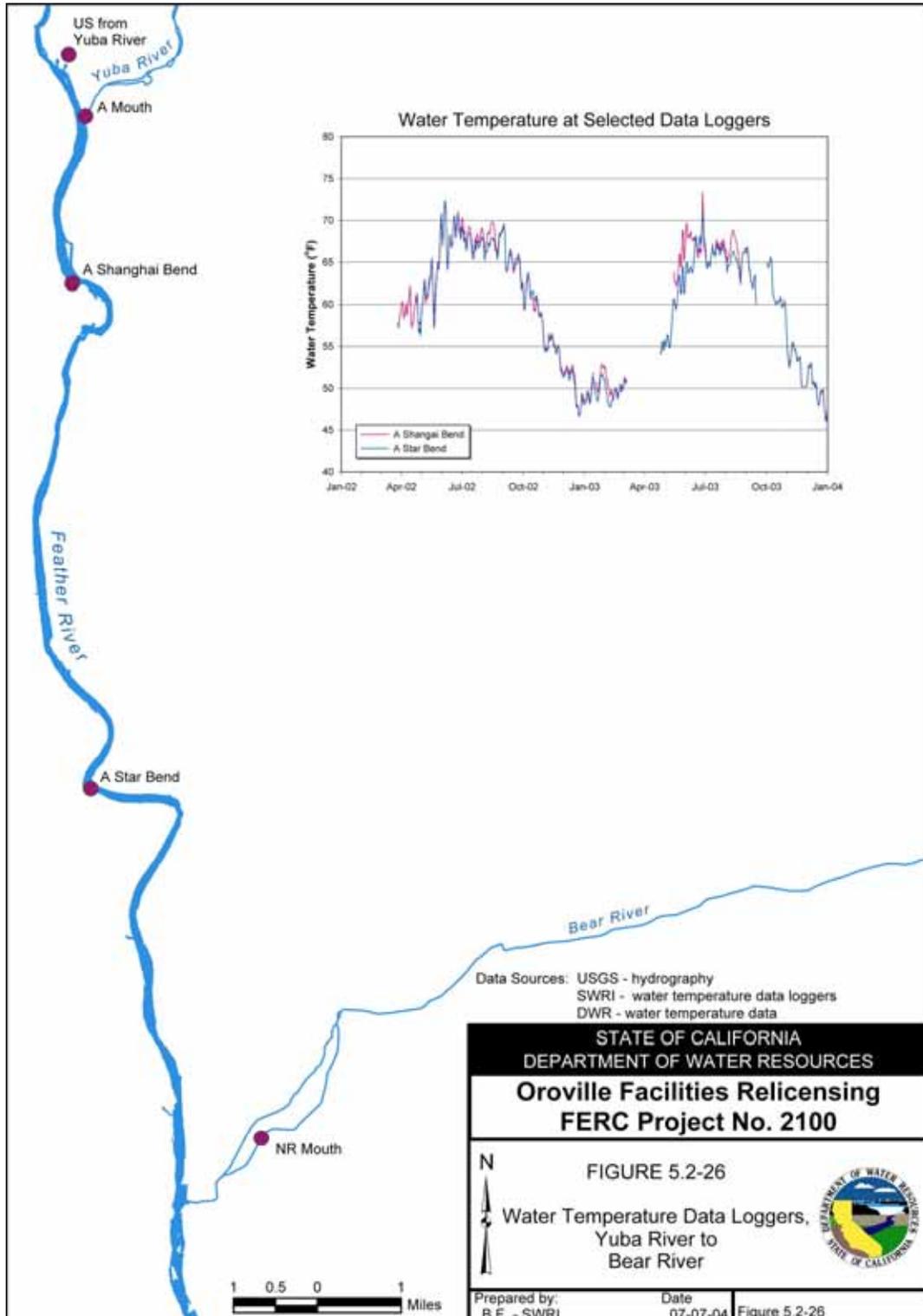


Figure 5.2-26. Water Temperature logger locations with selected logger time series graphs from Yuba River to Bear River.

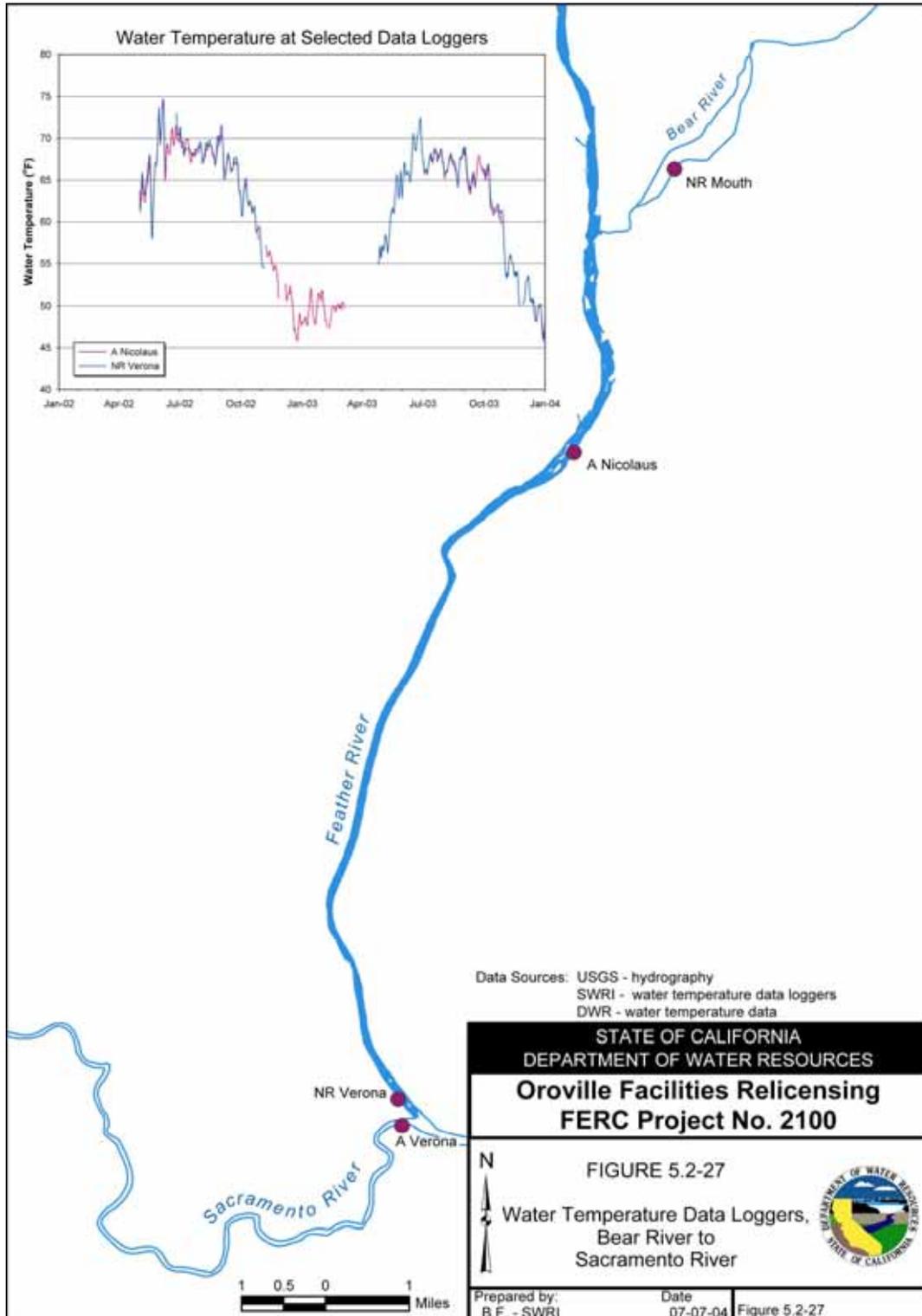


Figure 5.2-27. Water Temperature logger locations with selected logger time series graphs from Bear River to Sacramento River.

In addition to spatial water temperature variation within the water column and throughout the river, water temperatures vary temporally. The data only are representative of those months in which data were recorded and many of the water temperature loggers only recorded data during some months of the year. For example, the "NR Verona" thermograph only recorded temperatures from May through November, and did not record temperatures during the colder months of December, January and February. Water temperature analysis based on the "NR Verona" thermograph data was limited to the time period for which data were available.

### **5.2.5.3 Data Use**

Because each of the thermographs recorded water temperatures at specific points along the river, the data obtained from each thermograph were extrapolated to represent larger sections of the river. Sections were created by dividing the river at every point midway between each selected water temperature data logger: A section's upstream boundary was defined as the midpoint between the subject thermograph and the subsequent upstream thermograph, and the downstream boundary was defined as the midpoint between the subject thermograph and the subsequent downstream thermograph.

Tributary inflow from Honcut Creek, the Yuba River, and the Bear River influences water temperature within the Feather River at, and downstream from, each tributary confluence. Therefore, the water temperatures in the reaches of the Feather River immediately downstream from each of the tributaries would be more accurately represented by the nearest thermograph downstream from the tributary mouth rather than the nearest thermograph upstream from the tributary mouth. The water temperature polygon boundaries were adjusted at each major tributary so that the water temperature logger section immediately upstream of each confluence ended at the confluence, even if the location was short of the midpoint.

Each mesohabitat unit acquired the water temperature attributes for the geographically corresponding data logger section. Wherever multiple data logger sections overlaid a single mesohabitat unit, the mesohabitat unit was divided so that it could acquire the appropriate water temperature attributes.

For each fish species and life stage, suitable minimum and maximum water temperatures were determined based on a review of available published literature, the results of which are summarized in the Final Report for SP-F3.2 Task 2 (DWR 2004d). If a mesohabitat unit met all of the required suitability criteria for mesohabitat type, substrate, and depth, then a calculation was performed to determine the percentage of thermograph data occurrences in which the mean daily water temperature fell within the suitable water temperature range for that unit. If a habitat unit fell within the highest proportion of relative suitability class (90 percent to 100 percent class) for a species, but

water temperatures were outside the reported suitability range for that species, the habitat units fell into either the 25 percent to 49 percent, 50 percent to 74 percent, or 75 to 90 percent proportion of relative habitat suitability class depending on the proportion of time during which the water temperatures were outside the reported suitability range for each species. The proportion of time during which water temperatures were within the reported suitability range for each species was calculated against the available data to compensate for water temperature data gaps during the analysis periods. The percentage of suitable data logger occurrences was added as an attribute to the fish habitat classification.

The proportion of habitat units within the entire Feather River in which the proportion of relative habitat suitability class could change varies depending on the species and location of the intermediate proportion of relative habitat suitability classes. For example, future increases in cold-water releases into the LFC could potentially decrease the proportion of relative habitat suitability of some habitat units in the LFC for centrarchids by lowering water temperatures during some portions of the year while increasing the proportion of relative habitat suitability in those units for salmonids. Additionally, similar effects could potentially occur below the Thermalito Afterbay Outlet.

## **5.2.6 Water Quality Exceedances of Aquatic Life Criteria**

### **5.2.6.1 Data summary**

The geographic distribution of exceedance of water quality parameters established by EPA for aquatic life were mapped in the GIS to determine the number of exceedances that occurred at each sample location and river reach for each water quality parameter. The resulting exceedance counts were used to create a summary table of the proportion of water quality exceedances within each reach. The term “percentage exceedance” was defined as the percentage of samples that exceeded the water quality guideline for each constituent and was used to provide a relative and absolute indication of water quality within each reach.

Water quality samples were taken from 17 water quality stations at various locations in the lower Feather River (Figures 4.1-2 and 4.2-2). Exceedances occurred for three constituents: total aluminum, total iron, and total copper. Aluminum is acutely toxic to fish in acidic waters (Baldigo and Murdoch 1997). The gill is the principal target organ and death is due to a combination of ion-regulatory, osmoregulatory, and respiratory malfunctions. Aluminum kills fish in at least two ways. First, it is able to reduce the ion exchange through the gills causing salt depletion. Aluminum also precipitates in the gills and interferes with the normal transport of oxygen and other ions, so that the fish dies of a lack of oxygen. In addition, the fish will exude mucus to combat the aluminum in their gills (EPA 1988). Copper is a micronutrient that also can be highly toxic in aquatic environments. It affects fish species by bioaccumulating in many different organs (EPA 1985; EPA 1993). Additionally, copper adsorbs to organic matter,

carbonates, and clay, which reduces its bioavailability. There is a moderate potential for bioaccumulation in plants, a low potential for bioconcentration by fish, and no biomagnification. Fish, invertebrates, and aquatic plants appear to be equally sensitive to chronic toxicity. Ferric ion precipitation or adsorption as ferric hydroxide (or ferric oxide) on fish gills may result in suffocation (EPA 1986). EPA currently is revising the NAWQC aquatic life criterion for iron, which was originally established in 1973. Although EPA determined the need to update the water quality criteria for iron, EPA Report 1008466 has not yet been completed. Updated criteria for iron are due on August 30, 2004. Exceedance values were reported based on the 1973 criteria (EPA 1973).

All seven sampling stations between the Thermalito Diversion Dam and the Thermalito Afterbay Outlet exceeded the chronic (i.e., four day average) NAWQC aquatic life criterion for total aluminum while two sampling stations exceeded the chronic CTR aquatic life criterion for total copper (Table 5.2-6). Data collected from the stations named "Feather R A Oroville" and "Feather R US from Hatchery" exceeded the total aluminum NAWQC aquatic life criterion in 5 out of 16 samples (i.e., 31 percent). At the sampling location named "Feather R Hatchery Settling PD," 3 out of 14 samples (i.e., 21 percent) exceeded the total aluminum NAWQC aquatic life criterion and one out of 14 samples (i.e., 7 percent) exceeded the CTR aquatic life criterion for total copper. At the sampling location named "Feather R DS Hatchery," 2 out of 16 samples (i.e., 13 percent) exceeded the total aluminum NAWQC aquatic life criterion and one out of 16 (i.e., 6 percent) exceeded the CTR aquatic life criterion for total copper. At the location named "Feather R DS Hwy 162," 2 out of 17 samples (i.e., 12 percent) exceeded the total aluminum NAWQC aquatic life criterion. At the location named "Feather R A Robinson Riffle," 3 out of 16 samples (i.e., 19 percent) exceeded the total aluminum NAWQC aquatic life criterion. At the location named "Feather R US from Afterbay OL," 1 out of 16 samples (i.e., 6 percent) exceeded the total aluminum NAWQC aquatic life criterion. A more complete treatment of all of the water quality sampling results shall be provided by DWR in the Final Report for SP-W1, which is scheduled to be delivered July 2004.

All five sampling stations between the Thermalito Afterbay Outlet and Honcut Creek exceeded the chronic (i.e., four day average) NAWQC aquatic life criterion for total aluminum (Table 5.2-7). At the sampling location named "Feather R DS Afterbay OL," 7 out of 16 samples (i.e., 44%) exceeded the total aluminum NAWQC aquatic life criterion. At the sampling location named "Feather R DS SCOR OL Left Bank," 10 out of 17 samples (i.e., 59%) exceeded the total aluminum NAWQC aquatic life criterion. At the sampling location named "Feather R NR Mile Long PD," 5 out of 16 samples (i.e., 31%) exceeded the total aluminum NAWQC aquatic life criterion. At the sampling location named "Feather R DS Project BNDRY," 10 out of 16 samples (i.e., 63%) exceeded the total aluminum NAWQC aquatic life criterion. At the sampling location named "Feather R A Singh AB Riviera RD," sampling station, 11 out of 18 samples (i.e., 61%) exceeded the total aluminum NAWQC aquatic life standard.

**Table 5.2-6. Summary table of water quality aquatic life criteria exceedances for total metals (mg/L) in the Lower Feather River from the Diversion Dam to the Afterbay Outlet.**

	<b>Aluminum</b>	<b>Copper</b>	<b>Iron</b>
Feather R A Oroville: number of samples	16	16	16
Number and % of samples exceeding criteria or objectives			
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	5 (31%)	-	0
Feather R US from Hatchery: number of samples	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	5 (31%)	-	0
Feather R Hatchery Settling Pond: number of samples	14	14	14
CTR Aquatic Life	-	1 (7%)	-
NAWQC Aquatic Life	3 (21%)	-	0
Feather R DS Hatchery: number of samples	16	16	16
CTR Aquatic Life	-	1 (6%)	-
NAWQC Aquatic Life	2 (13%)	-	0
Feather R DS HWY 162: number of samples	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	2 (12%)	-	0
Feather R A Robinson Riffle: number of samples	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	3 (19%)	-	0
Feather R US Afterbay Outlet: number of samples	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	1 (6%)	-	0

**Table 5.2-7. Summary table of water quality aquatic life criteria exceedances for total metals (mg/L) in the Lower Feather River from the Afterbay Outlet to Honcut Creek.**

	<b>Aluminum</b>	<b>Copper</b>	<b>Iron</b>
Feather R DS Afterbay Outlet: Number of samples	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	7 (44%)	-	0
Feather R DS SCOR OL: Number of samples	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	10 (59%)	-	0
Feather R NR Mile-Long Pond Number of samples	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	5 (31%)	-	0
Feather R DS Project Boundary: Number of samples	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	10 (63%)	-	0
Feather R A Singh AB Riviera RD Number of samples	18	18	18
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	11 (61%)	-	0

All three sampling stations between Honcut Creek and the Yuba River exceeded the chronic (i.e., four day average) NAWQC aquatic life criterion for total aluminum, one

station exceeded the NAWQC aquatic life criterion for total iron, and one sampling station exceeded the chronic CTR aquatic life criterion for total copper (Table 5.2-7). At the sampling location named “Feather R A Archer AVE,” 10 out of 17 samples (i.e., 59%) exceeded the total aluminum NAWQC aquatic life criterion. At the sampling location named “Yuba R A MO,” 12 out of 16 samples (i.e., 71%) exceeded the total aluminum NAWQC aquatic life criterion. At the sampling station named “Feather R US Yuba R,” 16 out of 16 samples (i.e., 100%) and 1 out of 16 samples (i.e., 6%) exceeded the total aluminum and iron NAWQC aquatic life criteria, respectively. At the same location, one out of 16 samples (i.e., 6%) exceeded the chronic CTR aquatic life criterion for total copper.

**Table 5.2-8. Summary table of water quality aquatic life criteria exceedances for total metals (mg/L) in the Lower Feather River from Honcut Creek to the Yuba River.**

	Aluminum	Copper	Iron
Feather R A Archer Ave Number of samples	17	17	17
Number and % of samples exceeding criteria or objectives			
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	10 (59%)	-	0
Yuba R A Mouth Number of samples	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	12 (71%)	-	0
Feather R US Yuba R Number of samples	16	16	16
CTR Aquatic Life	-	1 (6%)	-
NAWQC Aquatic Life	16 (100%)	-	1 (6%)

At the single sampling location between the Yuba River and the Bear River, all samples (i.e., 100%) exceeded the chronic NAWQC aquatic life criterion for total aluminum, 2 out of 16 samples (13%) exceeded the NAWQC aquatic life criterion for total iron, and 1 out of 16 samples (i.e., 6%) exceeded the chronic CTR aquatic life criterion for total copper (Table 5.2-9).

**Table 5.2-9. Summary table of water quality aquatic life criteria exceedances for total metals (mg/L) in the Lower Feather River from the Yuba River to the Bear River.**

	Aluminum	Copper	Iron
Feather R A Shanghai Bend Number of samples	16	16	16
Number and % of samples exceeding criteria or objectives			
CTR Aquatic Life	-	1 (6%)	-
NAWQC Aquatic Life	16 (100%)	-	2 (13%)

The sampling station between the Bear River and the confluence with the Sacramento River exceeded the NAWQC aquatic life standards for total aluminum and total iron and the CTR aquatic life standard for total copper (Table 5.2-10). At the single sampling location between the Bear River and the confluence of the Feather River and Sacramento River, all samples (i.e., 100%) exceeded the chronic NAWQC aquatic life standard for total aluminum, 3 out of 16 samples (19%) exceeded the NAWQC aquatic

life standard for total iron, and 1 out of 16 samples (i.e., 6%) exceeded the chronic CTR aquatic life standard for total copper.

**Table 5.2-10. Summary table of water quality aquatic life criteria exceedances for total metals (mg/L) in the Lower Feather River from the Bear River to the confluence with the Sacramento River.**

	Aluminum	Copper	Iron
Feather R NR Verona Number of samples	16	16	16
Number and % of samples exceeding criteria or objectives			
CTR Aquatic Life	-	1 (6.25%)	-
NAWQC Aquatic Life	16 (100%)	-	3 (18.75%)

### 5.2.6.2 Data Limitations

Water quality samples represent the water quality conditions at a specific site location and time and may not be representative of a geographic or temporal range of conditions. The Final Report for SP-W1 is scheduled for delivery by DWR in July 2004 and shall contain additional analyses relevant to water quality in the lower Feather River. Because data available for this analysis did not include dates during which exceedance of each criterion occurred, detailed analysis of duration of exposure for each species and life stage was not possible. Additionally, data available for this analysis did not include the magnitude of exceedance of each criterion. Therefore, analysis of the magnitude of exposure for each species and life stage was not possible.

### 5.2.6.3 Data Use

Water quality station geographic locations were intersected with individual fish species distributions to determine the number of water quality aquatic life criteria exceedances that occurred within the geographic distribution range of each species. Table 5.2-11 shows a summary of aquatic life criteria exceedances in the lower Feather River. During this analysis, point location water quality exceedances were not extrapolated, but a relative proportion of samples that exceeded water quality criteria was presented.

## 5.2.7 Dissolved Oxygen

### 5.2.7.1 Data Summary

A total of 1,477 DO concentration samples were collected at sixteen locations. The lowest and highest recorded DO concentrations were 8.3 mg/L and 12.0 mg/L respectively, with a mean of 10.1 mg/L. Monthly and bi-monthly samples of DO concentration at ½-meter depth intervals, in sixteen locations, over a 16-month period, have shown that DO concentration did not stratify in the river and that the maximum observed DO concentration gradient in the depth profile of a single sample location was 1.0 mg/l.

**Table 5.2-11. Summary of aquatic life criteria exceedances in the lower Feather River.**

<b>LFC</b>	<b>Aluminum</b>	<b>Copper</b>	<b>Iron</b>
Feather R A Oroville	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	5 (31%)	-	0
Feather R US from Hatchery	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	5 (31%)	-	0
Feather R Hatchery Settling Pond	14	14	14
CTR Aquatic Life	-	1 (7%)	-
NAWQC Aquatic Life	3 (21%)	-	0
Feather R DS Hatchery	16	16	16
CTR Aquatic Life	-	1 (6%)	-
NAWQC Aquatic Life	2 (13%)	-	0
Feather R DS HWY 162	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	2 (12%)	-	0
Feather R A Robinson Riffle	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	3 (19%)	-	0
Feather R US Afterbay Outlet	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	1 (6%)	-	0
<b>Total</b>	<b>21</b>	<b>2</b>	<b>0</b>
<b>Percentage</b>	<b>18.9</b>	<b>1.8</b>	<b>0</b>
<b>HFC</b>	<b>Aluminum</b>	<b>Copper</b>	<b>Iron</b>
Feather R DS Afterbay Outlet	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	7 (44%)	-	0
Feather R DS SCOR OL	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	10 (59%)	-	0
Feather R NR Mile-Long Pond	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	5 (31%)	-	0
Feather R DS Project Boundary	16	16	16
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	10 (63%)	-	0
Feather R A Singh AB Riviera RD	18	18	18
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	11 (61%)	-	0
Feather R A Archer Ave	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	10 (59%)	-	0
Yuba R A Mouth	17	17	17
CTR Aquatic Life	-	0	-
NAWQC Aquatic Life	12 (71%)	-	0
Feather R US Yuba R	16	16	16
CTR Aquatic Life	-	1 (6%)	-
NAWQC Aquatic Life	16 (100%)	-	1 (6%)
Feather R A Shanghai Bend	16	16	16
CTR Aquatic Life	-	1 (6%)	-

HFC (continued)	Aluminum	Copper	Iron
NAWQC Aquatic Life	16 (100%)	-	2 (13%)
Feather R NR Verona	16	16	16
CTR Aquatic Life	-	1 (6%)	-
NAWQC Aquatic Life	16 (100%)	-	3 (19%)
<b>Total</b>	<b>113</b>	<b>3</b>	<b>6</b>
<b>Percentage</b>	<b>68.5</b>	<b>1.8</b>	<b>3.6</b>

### 5.2.7.2 Data Limitations

Monthly and bi-monthly DO concentration sampling occurred over a range of times of day. Therefore, the recorded DO concentration measurements could potentially not have been recorded when DO concentrations were highest or lowest during the diel cycle. The samples collected only represented the DO concentration at the specific locations and times that sampling occurred. Thus, spatial and temporal generalization of the data was required for use as part of the fish habitat classification.

### 5.2.7.3 Data Use

Suitable minimum DO concentration criteria were established for the fish habitat classifications and were based on the DO concentrations reported by EPA to be sufficient to support coldwater aquatic species. In general, warmwater species covered in the scope of this study are less sensitive to low DO concentrations than coldwater species. The thirty-day mean dissolved oxygen concentration reported to be suitable for all life stages other than embryonic, larval, or juvenile organisms is reported to be 6.5 mg/L (EPA 2002). The thirty-day mean value was used because it is the most protective DO concentration value provided for post-juvenile life stages. None of the DO samples collected in the lower Feather River had DO concentrations less than 6.5 mg/L. Because all observed DO concentrations met the minimum DO concentration criteria, DO concentration was not included in the fish habitat queries as a potential exclusionary fish habitat variable.

## 5.3 FISH HABITAT DISTRIBUTION

Fish habitat distribution is a generalized representation of the range and proportion of relative habitat suitability by fish species. The range of proportion of relative habitat suitability is divided into 5 classes. The classes represent the relative proportion of fish habitat suitability and range from zero to 24 percent, 25 percent to 49 percent, 50 percent to 74 percent, 75 percent to 89 percent and 90 percent to 100 percent. The zero to 24 percent class of the proportion of relative fish habitat suitability is the lowest class of relative habitat suitability and represents those habitat units that either do not have one or more of the required habitat component attributes (i.e., suitable depth, substrate, etc) for the specific fish species, or the required fish habitat components are present within the habitat unit, but the water temperatures are outside of the species water temperature tolerance range for 75 percent or more of the calendar-period being

evaluated. The latter of the two potential cases (i.e., water temperatures outside the reported tolerance range of a species for 75 percent or more time during the life stage of the species) for the zero to 24 percent classification did not occur in these analyses. The 90 percent to 100 percent proportion of relative habitat suitability class is the highest class of relative habitat suitability and indicates that the habitat units meet all of the fish habitat component requirements and that water temperatures are within the water temperature tolerance range for the species for greater than 90 percent of the calendar-period analyzed. In order to determine whether a habitat unit would fall into either the zero to 24 percent relative habitat suitability class or into the 90 percent to 100 percent relative habitat suitability class, each of the required habitat components were analyzed for presence or absence in a binary fashion. If any one or more of the required habitat components were absent, the habitat unit automatically fell into the zero to 24 percent relative habitat suitability class. If all of the required habitat components were present in the unit, water temperatures were analyzed to determine the proportion of time that they were within or outside of the reported thermal tolerance ranges of the species. Habitat units that fell into the 90 percent to 100 percent proportion of relative habitat suitability class for a particular species had water temperatures within the reported thermal tolerance range of the species for greater than 90 percent of the calendar-period being analyzed. The areas of the lower Feather River classified as falling into the 25 percent to 49 percent, 50 percent 74 percent, and 75 percent to 89 percent proportion of relative habitat suitability classes met all of the fish habitat component requirements but had lower proportions of time with suitable water temperatures present. The proportional relative habitat suitability class represents the percentage of time during the calendar-period evaluated for a fish species that the water temperatures were within the tolerance range specified for the species. In locations where the available water temperature data set was incomplete for the analysis period, the proportion of time the habitat was relatively suitable was normalized to reflect the proportion of time that the water temperatures were suitable for the amount of time that data were available.

### **5.3.1 Data Summary**

Fish habitat distribution was presented by the number of acres and the proportion of total fish habitat that was within each proportion of relative habitat suitability class. The habitat distribution for 15 fish species was evaluated for each of 5 lower Feather River reaches as well as for the entire lower Feather River.

#### **5.3.1.1 American Shad**

Between the Fish Barrier Dam and the Thermalito Afterbay Outlet, 50 acres (i.e., 18 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for American shad, and 225 acres (i.e., 82 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-1).

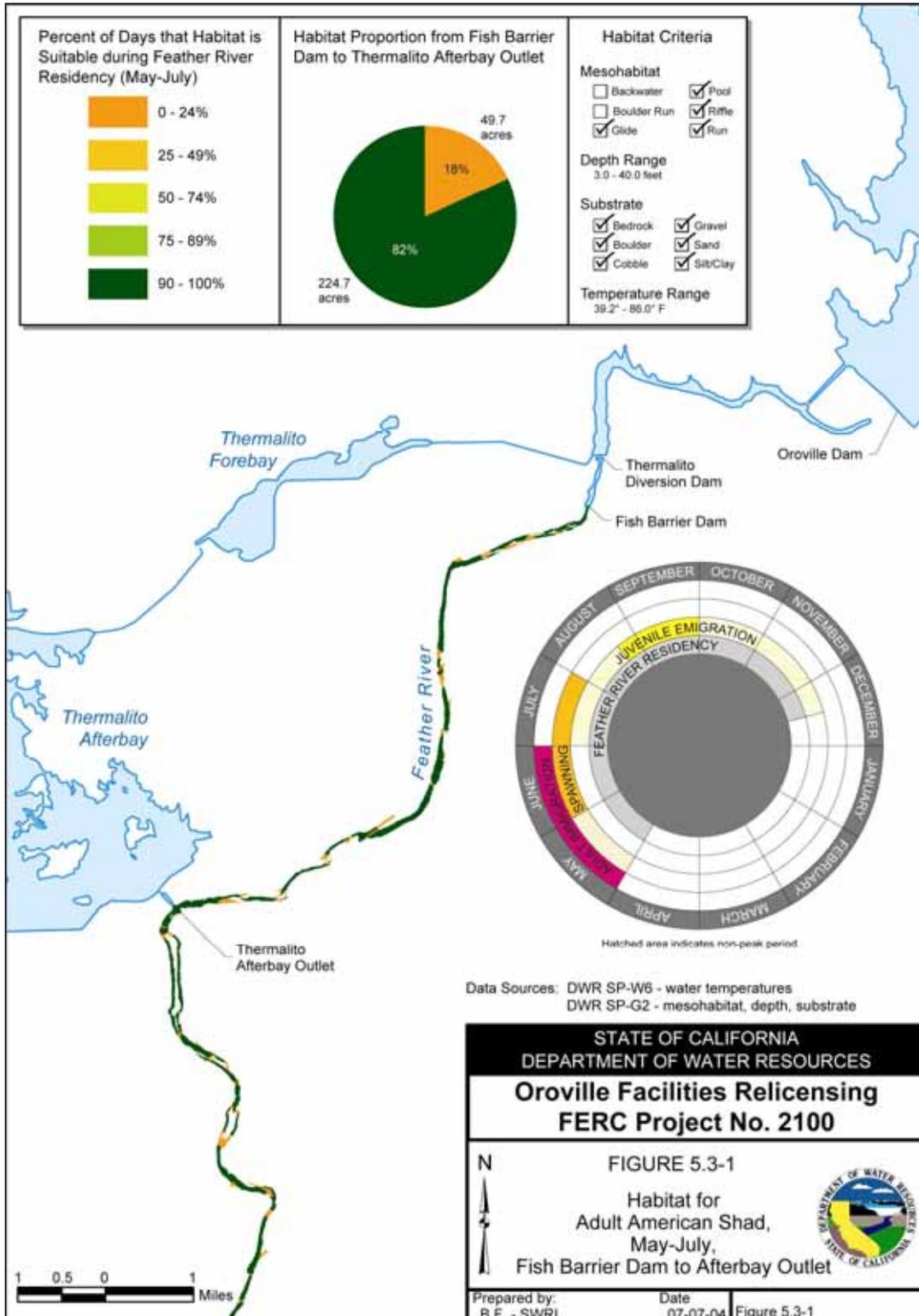


Figure 5.3-1. American Shad habitat in the lower Feather River from the Fish Barrier Dam to the Afterbay Outlet.

Between the Thermalito Afterbay Outlet and Honcut Creek, 76 acres (i.e., 14 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) suitability for American shad, and 474 acres (i.e., 86 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-2).

Between Honcut Creek and the Yuba River, 44 acres (i.e., 8 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for American shad, and 543 acres (i.e., 93 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-3).

Between the Yuba River and the Bear River, 4 acres (i.e., 0.4 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for American Shad, and 858 acres (i.e., 99 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-4).

Between the Bear River and the Feather River confluence with the Sacramento River, 6 acres (i.e., 1 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for American Shad, and 714 acres (i.e., 99 percent) of total available habitat fell within the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-5).

The proportion of total available habitat falling in the highest proportion or relative habitat suitability class for American Shad increased with distance downstream from the Fish Barrier Dam. Specifically, the proportion of mesohabitat units falling in the highest proportion of relative habitat suitability class neared 100 percent downstream from the mouth of the Yuba River. Thus, the total number of acres of river falling into the 90 percent to 100 percent proportion of relative habitat suitability class was highest below the mouth of the Yuba River. Figure 5.3-6 shows the proportion of habitat and proportion of relative habitat suitability classes for American shad by reach.

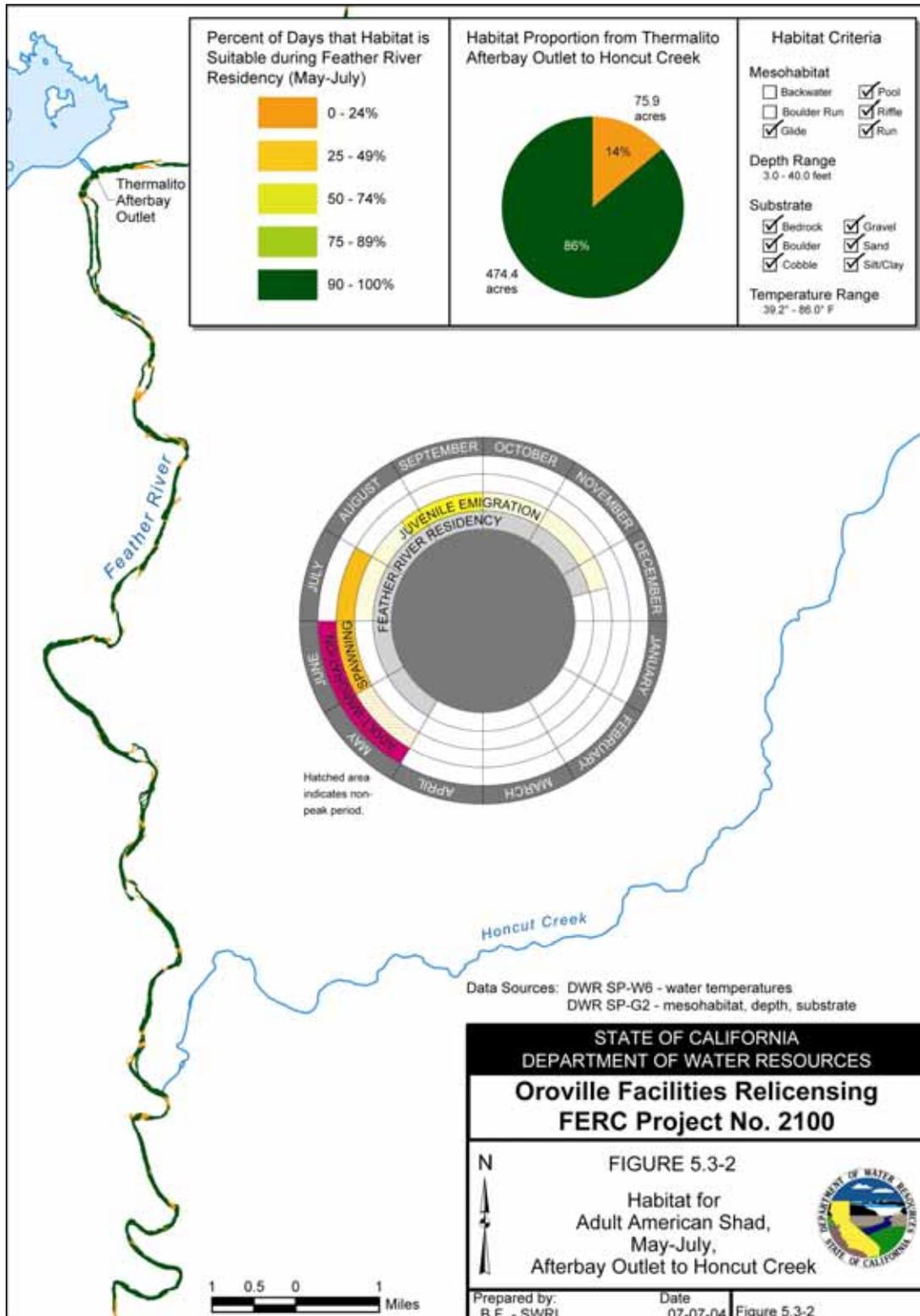


Figure 5.3-2. American Shad habitat in the lower Feather River from the Afterbay Outlet to Honcut Creek.

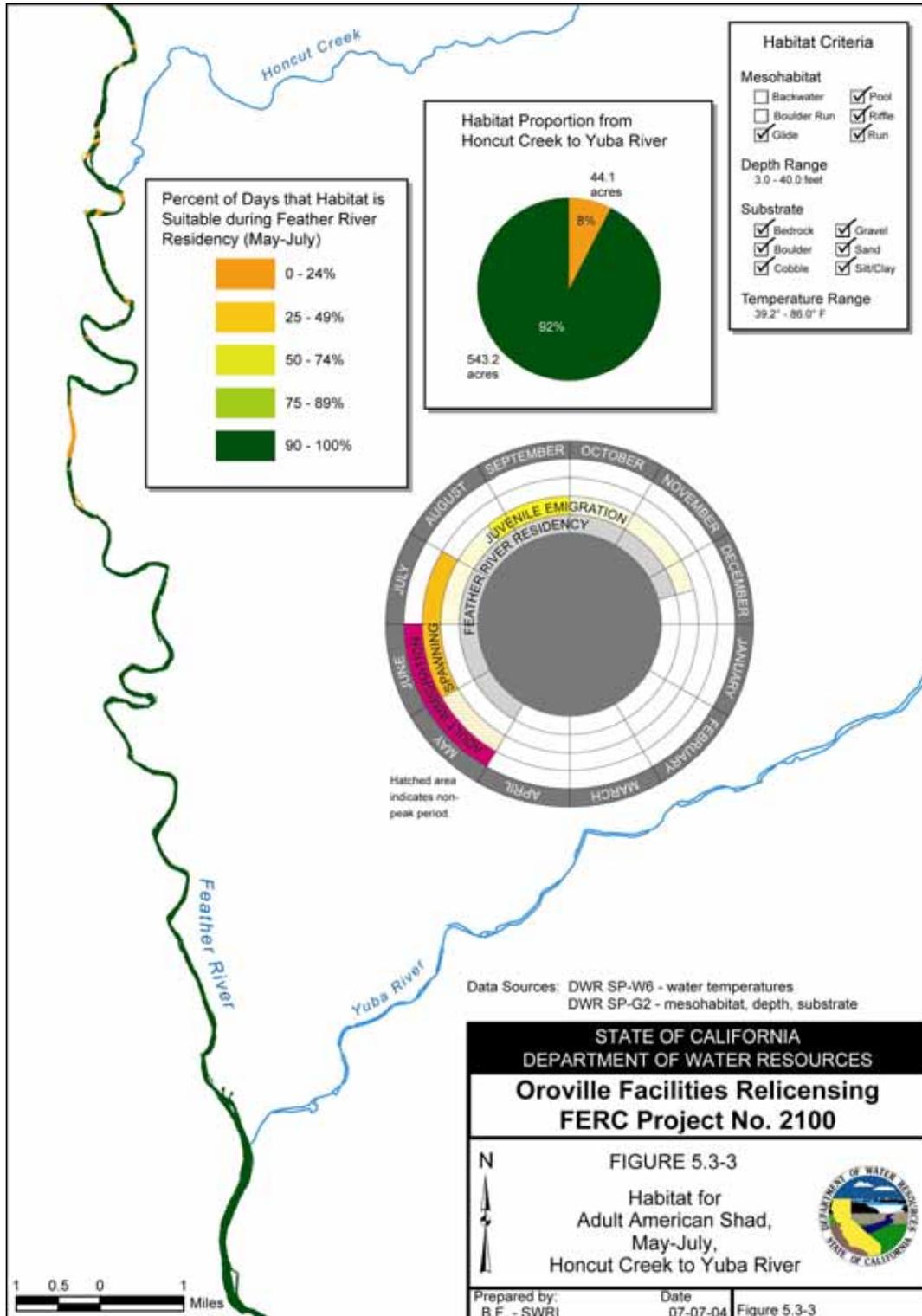


Figure 5.3-3. American Shad habitat in the lower Feather River from Honcut Creek to the Yuba River.

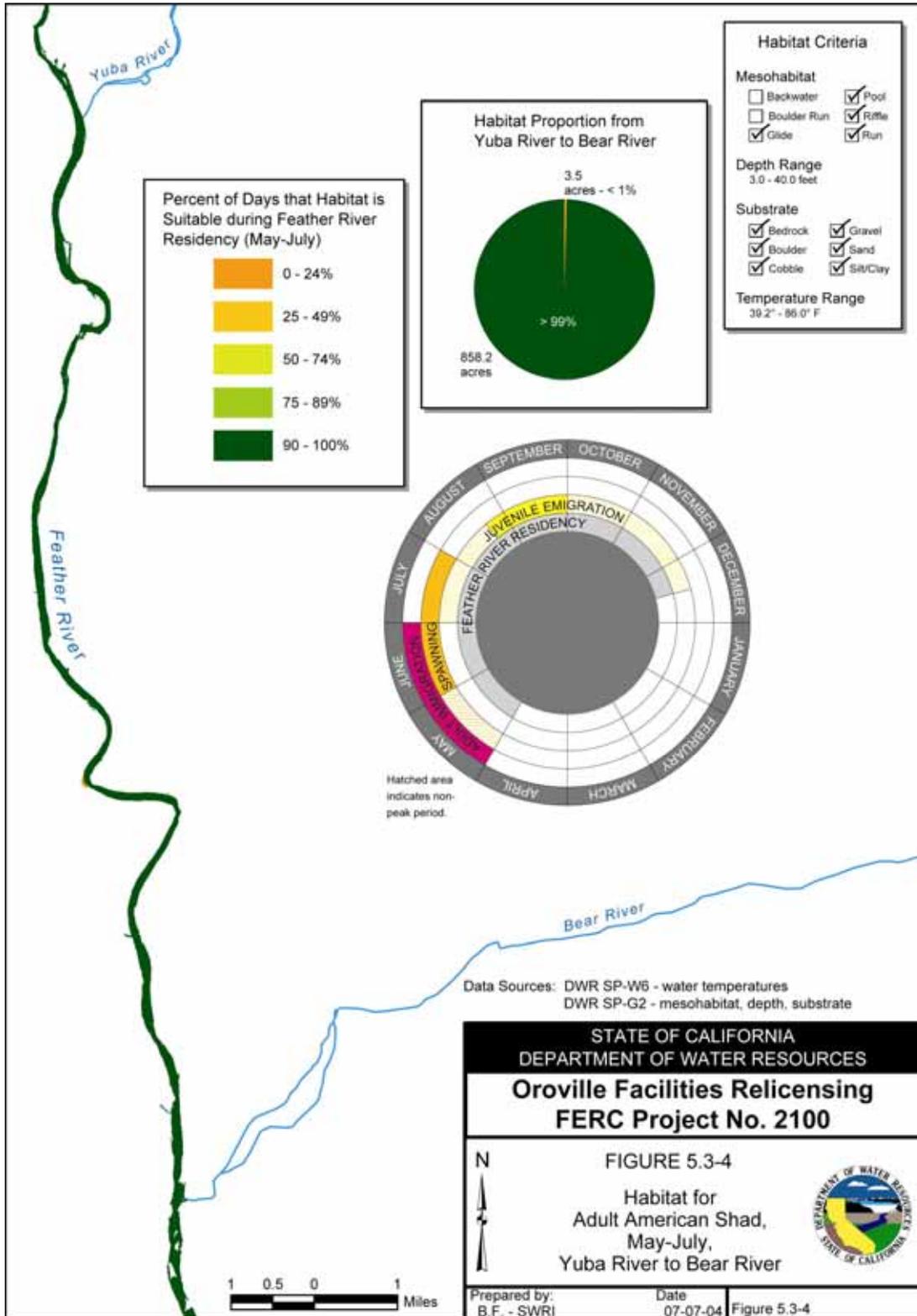


Figure 5.3-4. American Shad habitat in the lower Feather River from the Yuba River to Bear River.

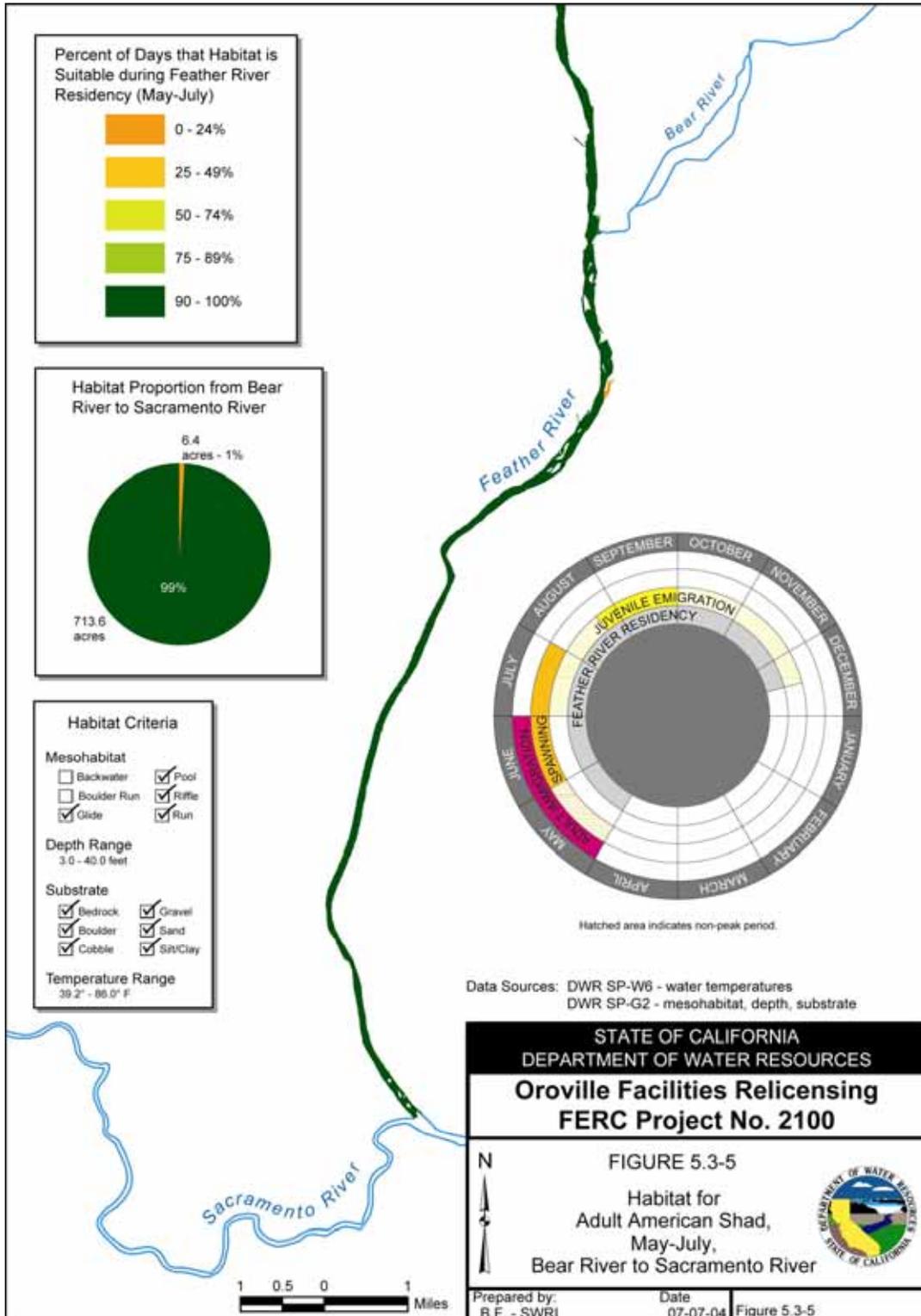
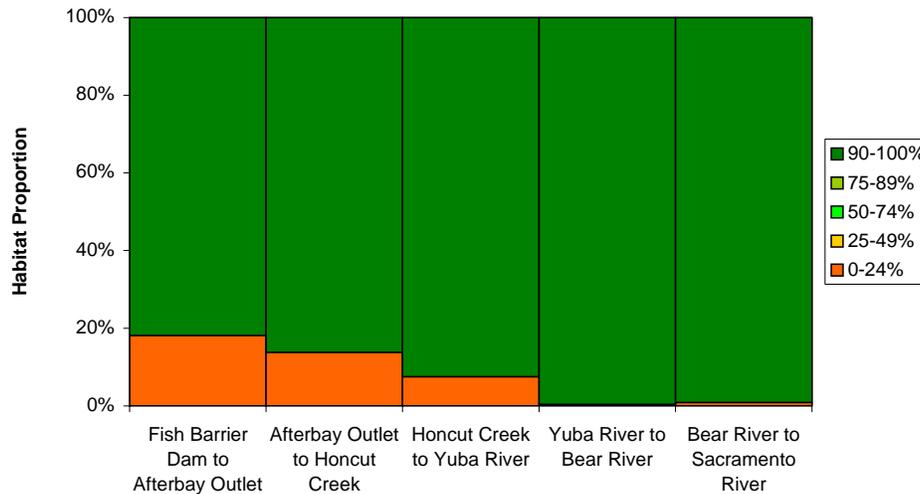


Figure 5.3-5. American Shad habitat in the lower Feather River from the Bear River to the Sacramento River.



**Figure 5.3-6. Proportion of fish habitat and relative habitat suitability for American Shad by reach in the lower Feather River.**

### 5.3.1.2 Centrarchids

Between the Fish Barrier Dam and the Thermalito Afterbay Outlet, 18 acres (i.e., 7 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent) for centrarchids, 35 acres (i.e., 13 percent) of total available habitat fell into the 50 percent to 74 percent proportion of relative habitat suitability class for centrarchids, 19 acres (i.e., 7 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class for centrarchids, and 203 acres (i.e., 74 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-7).

Between the Thermalito Afterbay Outlet and Honcut Creek, 62 acres (i.e., 11 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for centrarchids, 84 acres (i.e., 15 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class for centrarchids, and 404 acres (i.e., 73 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-8).

Between Honcut Creek and the Yuba River, 20 acres (i.e., 3 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for centrarchids, and 567 acres (i.e., 97 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-9).

Between the Yuba River and the Bear River, 8 acres (i.e., 1 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for centrarchids, 565 acres (i.e., 66 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class for centrarchids, and 289 acres (i.e., 34 percent) of total available habitat fell into the highest proportion of habitat suitability class (90 percent to 100 percent class) (Figure 5.3-10).

Between the Bear River and the Feather River confluence with the Sacramento River, 257 acres (i.e., 36 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class for centrarchids, and 464 acres (i.e., 64 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-11).

The proportion of total available habitat that fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) for centrarchids increased with distance downstream from the Fish Barrier Dam to the mouth of the Yuba River. From the mouth of the Yuba River to the mouth of the Feather River the proportion of total available habitat that fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) for centrarchids also increased with distance downstream. However the proportion of total available habitat that fell into the 90 percent to 100 percent proportion of relative habitat suitability class was lower downstream from the mouth of the Yuba River than upstream from it. Figure 5.3-12 shows the proportion of habitat and proportion of relative habitat suitability classes for centrarchids by reach.

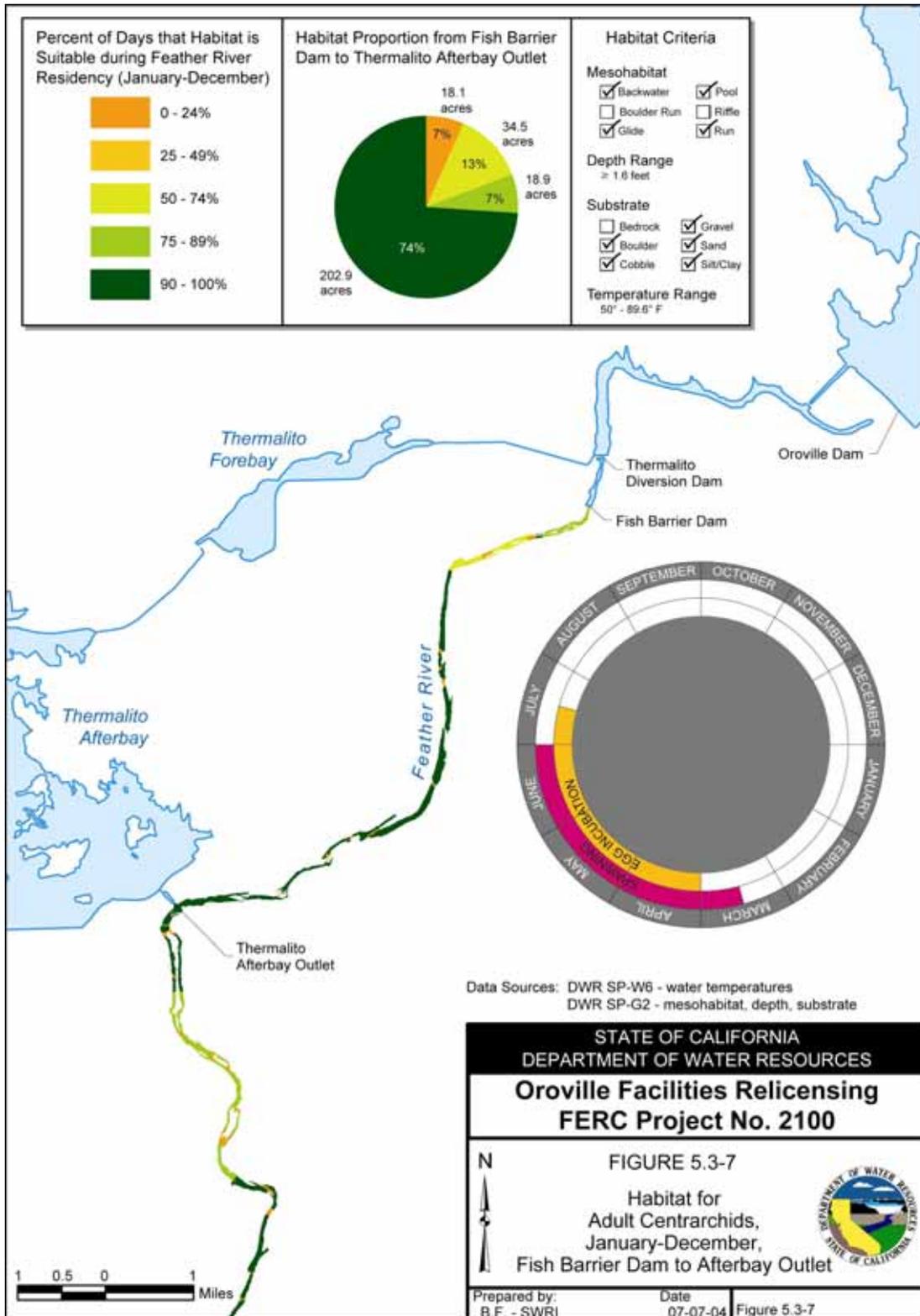


Figure 5.3-7. Centrarchid habitat in the lower Feather River from the Fish Barrier Dam to the Afterbay Outlet.

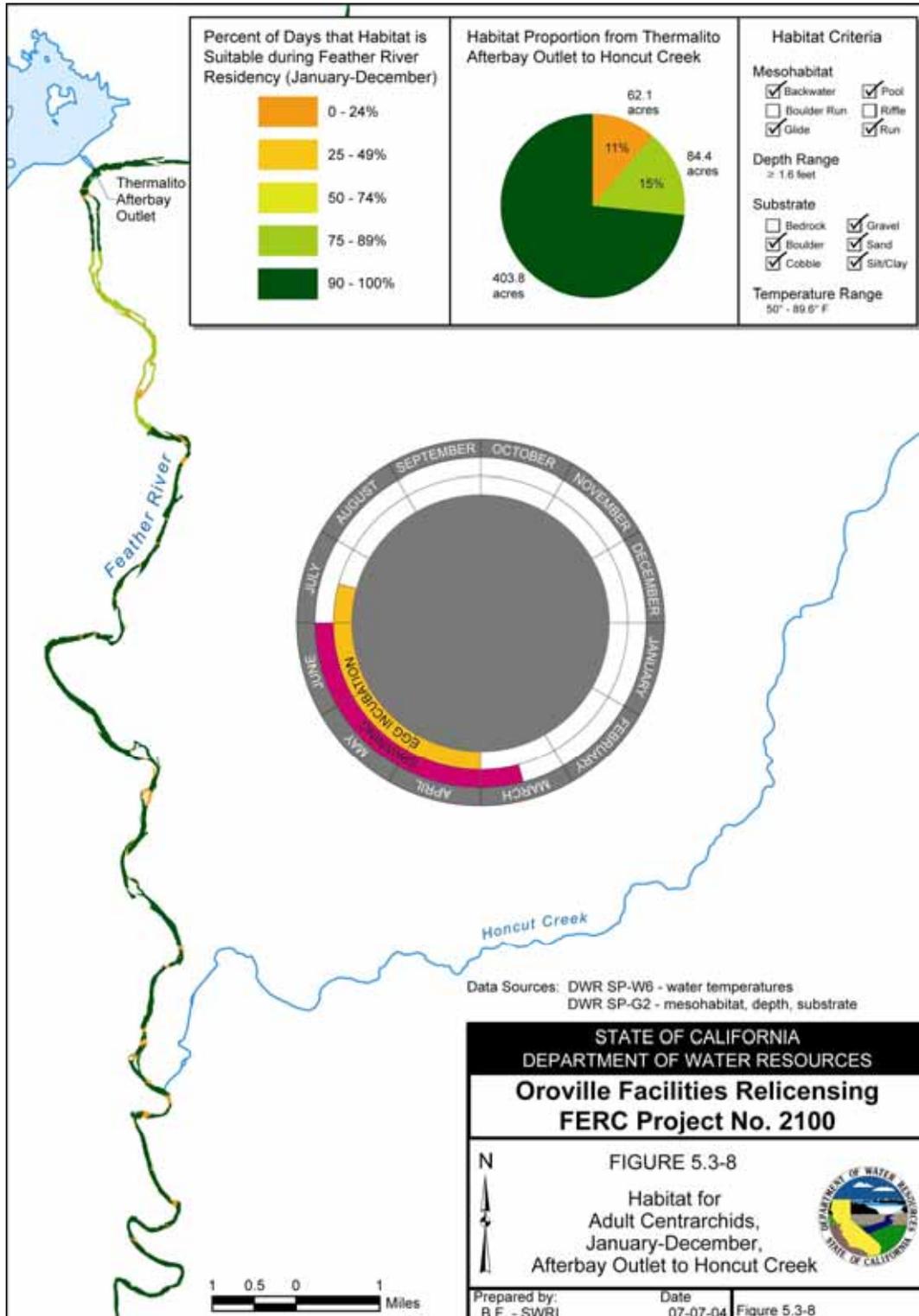


Figure 5.3-8. Centrachid habitat in the lower Feather River from the Afterbay Outlet to Honcut Creek.

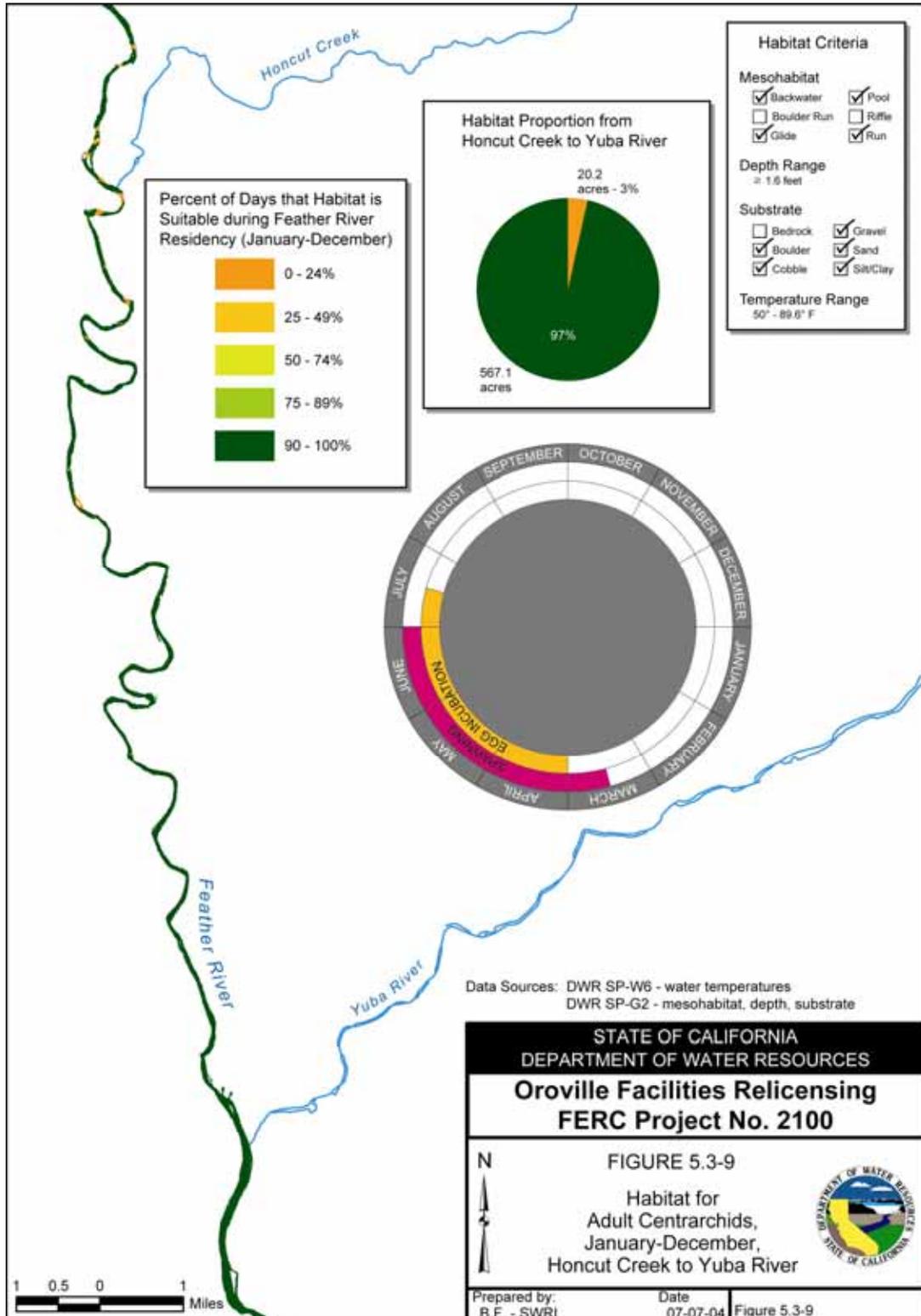


Figure 5.3-9. Centrarchid habitat in the lower Feather River from Honcut Creek to the Yuba River.

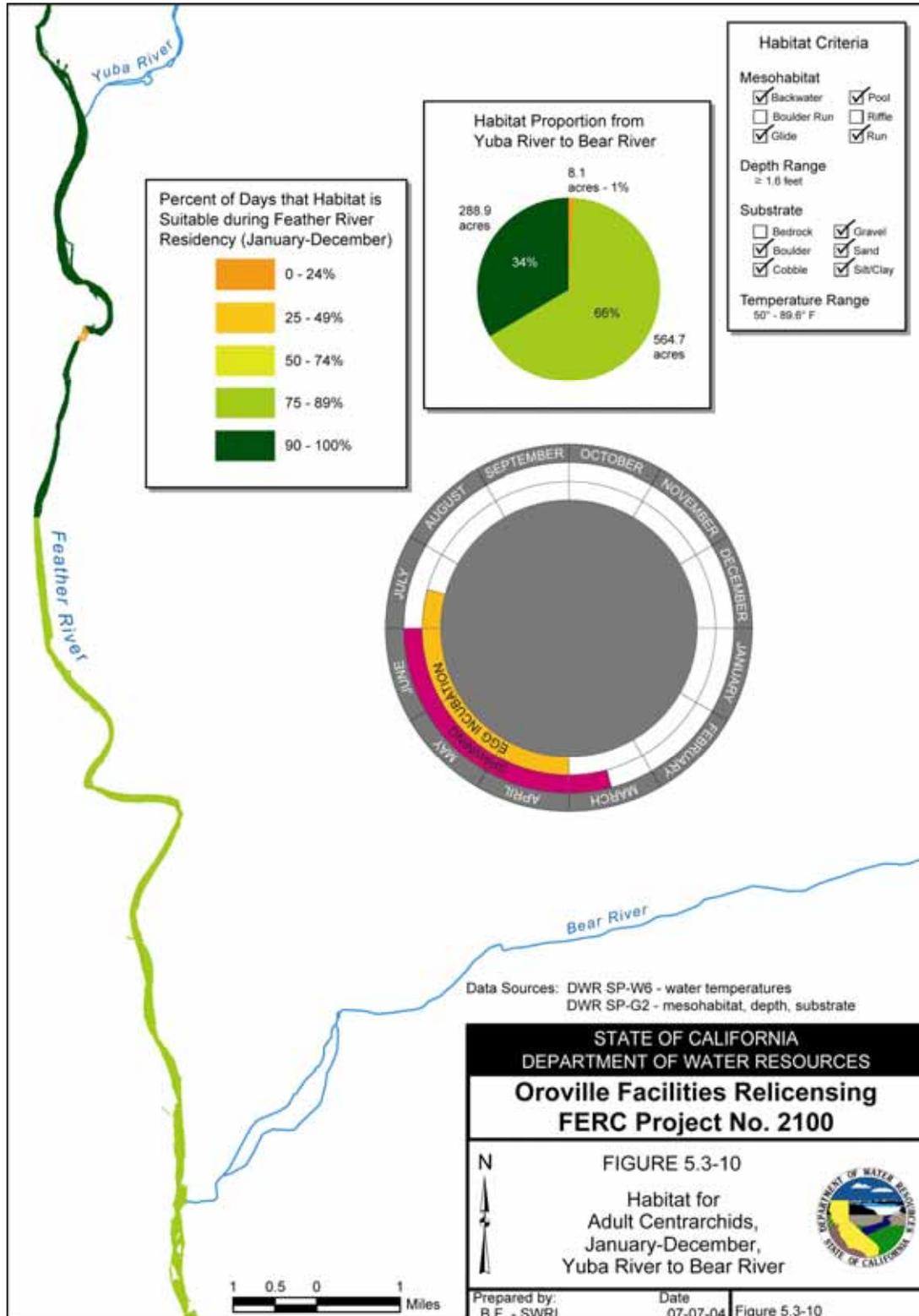


Figure 5.3-10. Centranichid habitat in the lower Feather River from the Yuba River to Bear River.

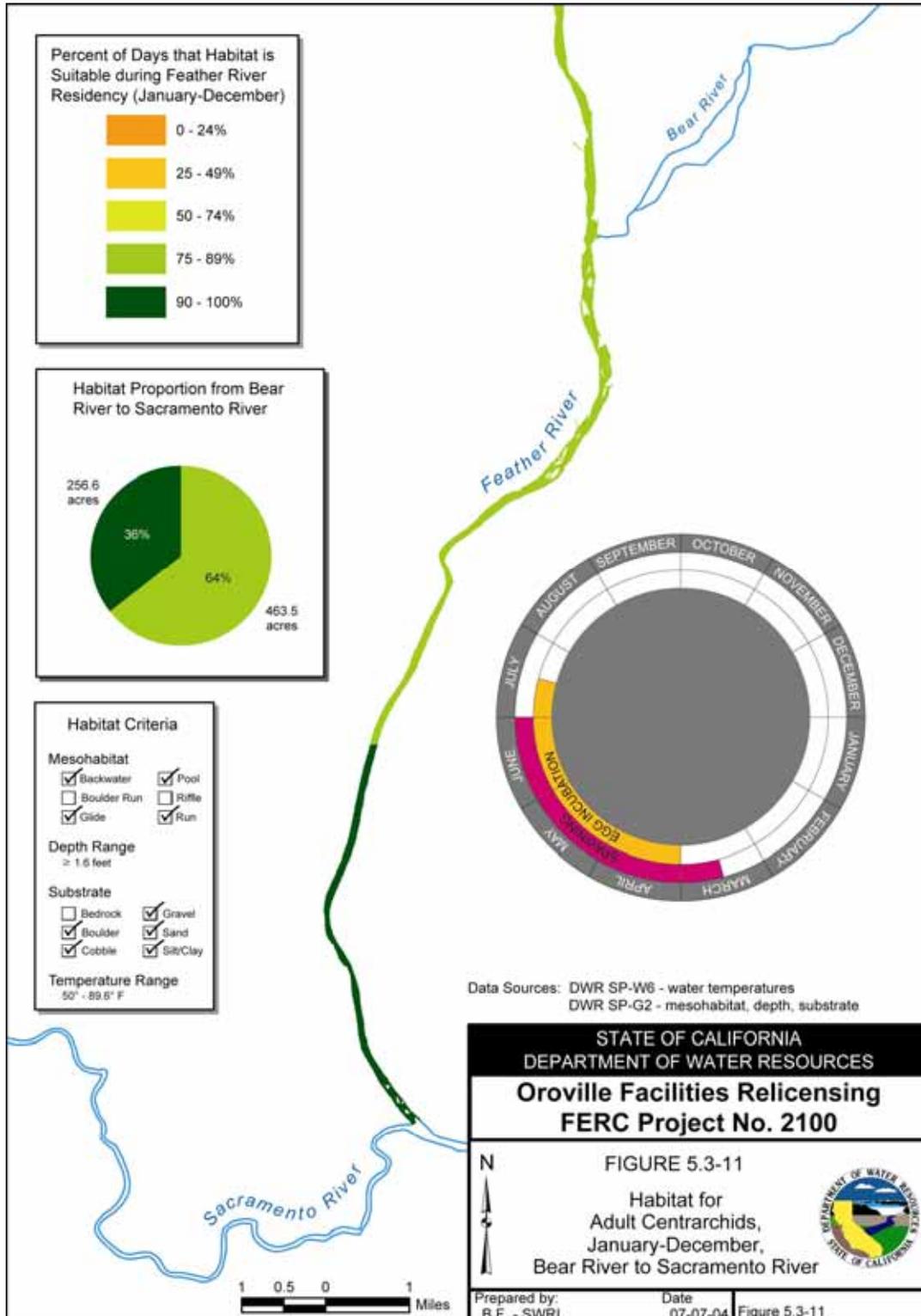
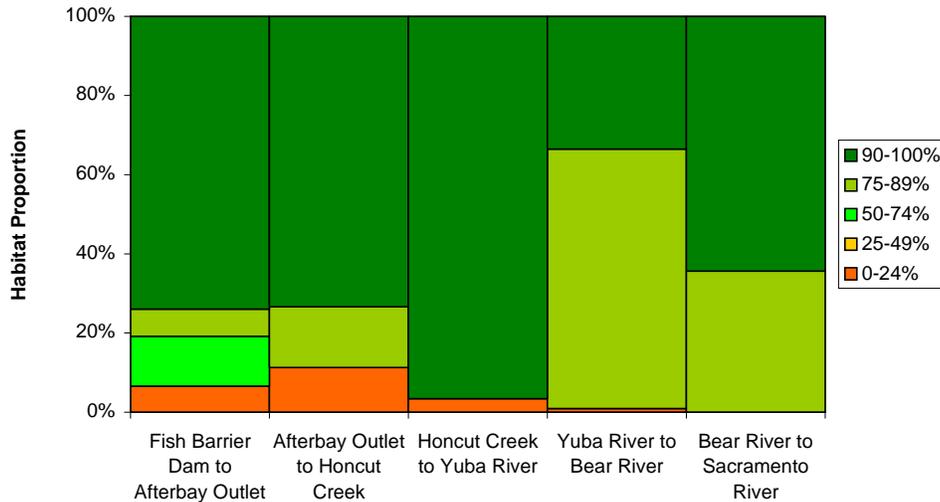


Figure 5.3-11. Centrarchid habitat in the lower Feather River from the Bear River to the Sacramento River.



**Figure 5.3-12. Proportion of fish habitat and relative habitat suitability for centrarchids by reach in the lower Feather River.**

### 5.3.1.3 Green Sturgeon

Between the Fish Barrier Dam and the Thermalito Afterbay Outlet, 133 acres (i.e., 48 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Green Sturgeon, and 142 acres (i.e., 52 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-13).

Between the Thermalito Afterbay Outlet and Honcut Creek, 382 acres (i.e., 69 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Green Sturgeon, and 168 acres (i.e., 31 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-14).

Between Honcut Creek and the Yuba River, 126 acres (i.e., 21 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Green Sturgeon, 267 acres (i.e., 45 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class for Green Sturgeon, and 195 acres (i.e., 33 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-15).

Between the Yuba River and the Bear River, 650 acres (i.e., 76 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Green Sturgeon, and 211 acres (i.e., 25 percent) of total available

habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-16).

Between the Bear River and the Feather River confluence with the Sacramento River, 6 acres (i.e., 1 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Green Sturgeon, and 714 acres (i.e., 99 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class. No available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) between the Bear River and the Mouth of the Feather River (Figure 5.3-17).

The proportion of total habitat that fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) for green sturgeon generally decreased with distance downstream from the Fish Barrier Dam while the proportion of total habitat that fell into the lowest proportion of relative habitat suitability class (zero to 100 percent class) generally increased in the same spatial area. The smallest proportion of total habitat that fell into the zero to 24 percent proportion of relative habitat suitability class for green sturgeon occurred downstream from the Bear River. However, no available habitat fell into the 90 percent to 100 percent proportion of relative habitat suitability class within that reach. Figure 5.3-18 shows the proportion of habitat and proportion of relative habitat suitability classes for green sturgeon by reach.

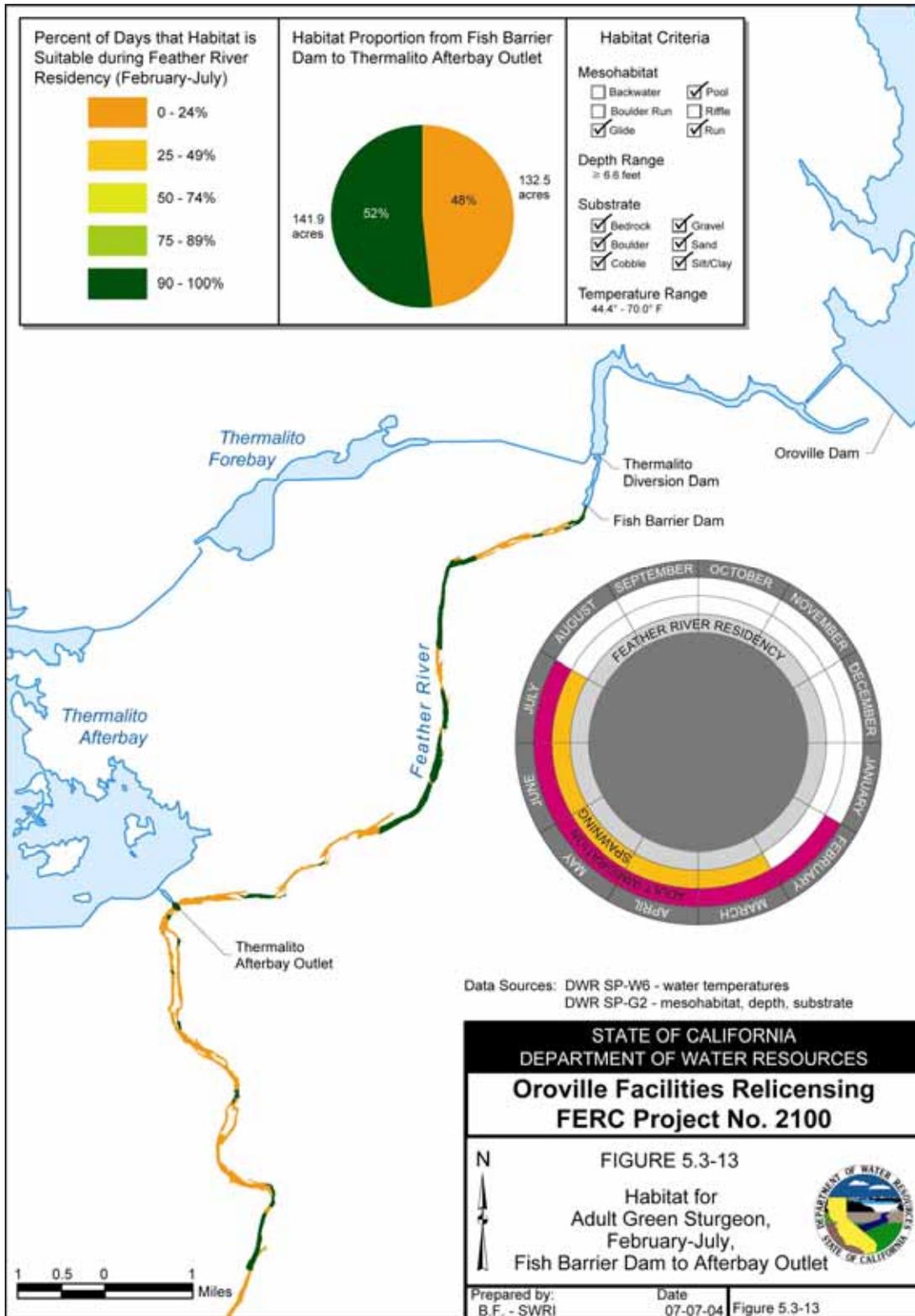


Figure 5.3-13. Green sturgeon habitat in the lower Feather River from the Fish Barrier Dam to the Afterbay Outlet.

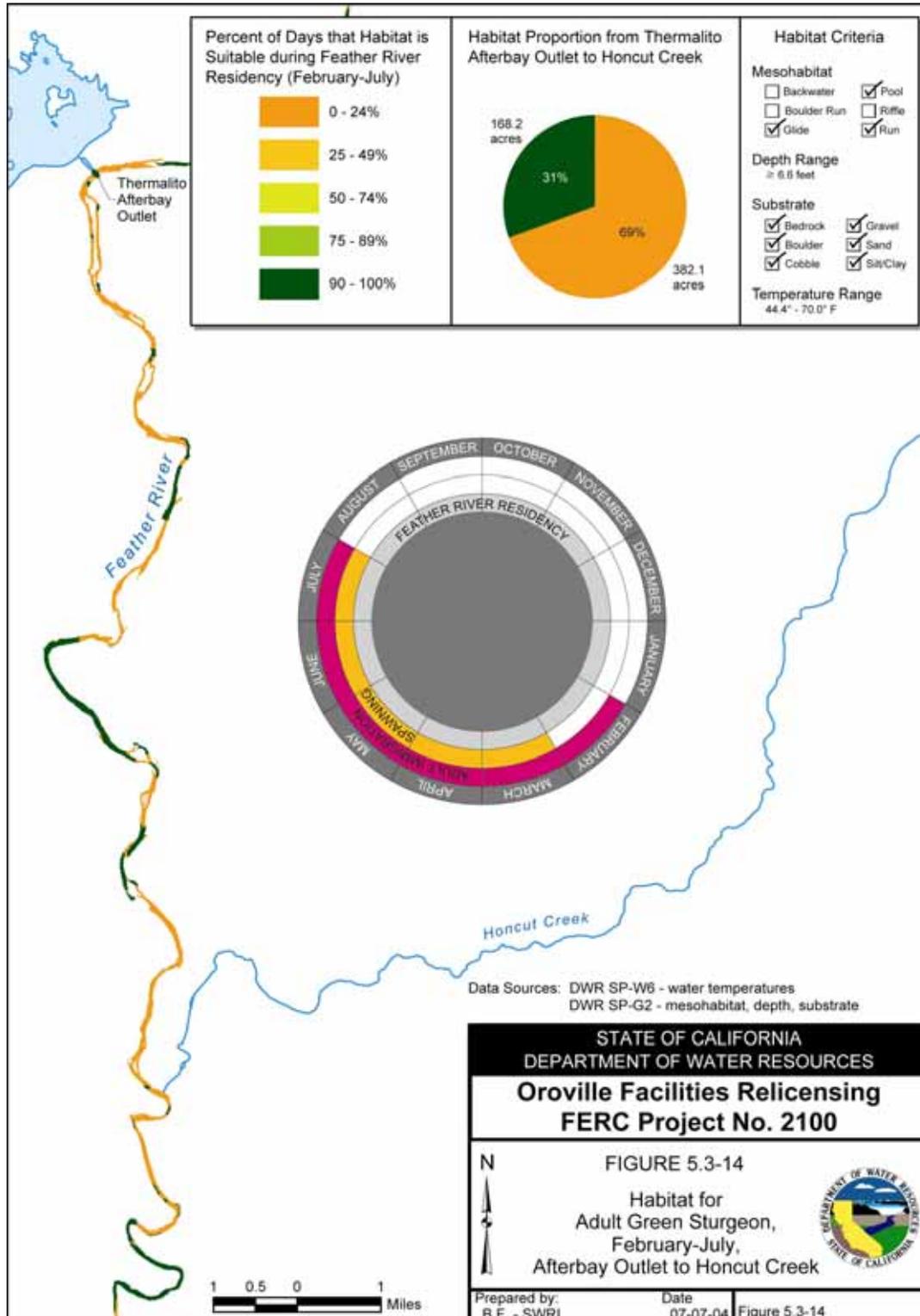


Figure 5.3-14. Green sturgeon habitat in the lower Feather River from the Afterbay Outlet to Honcut Creek.

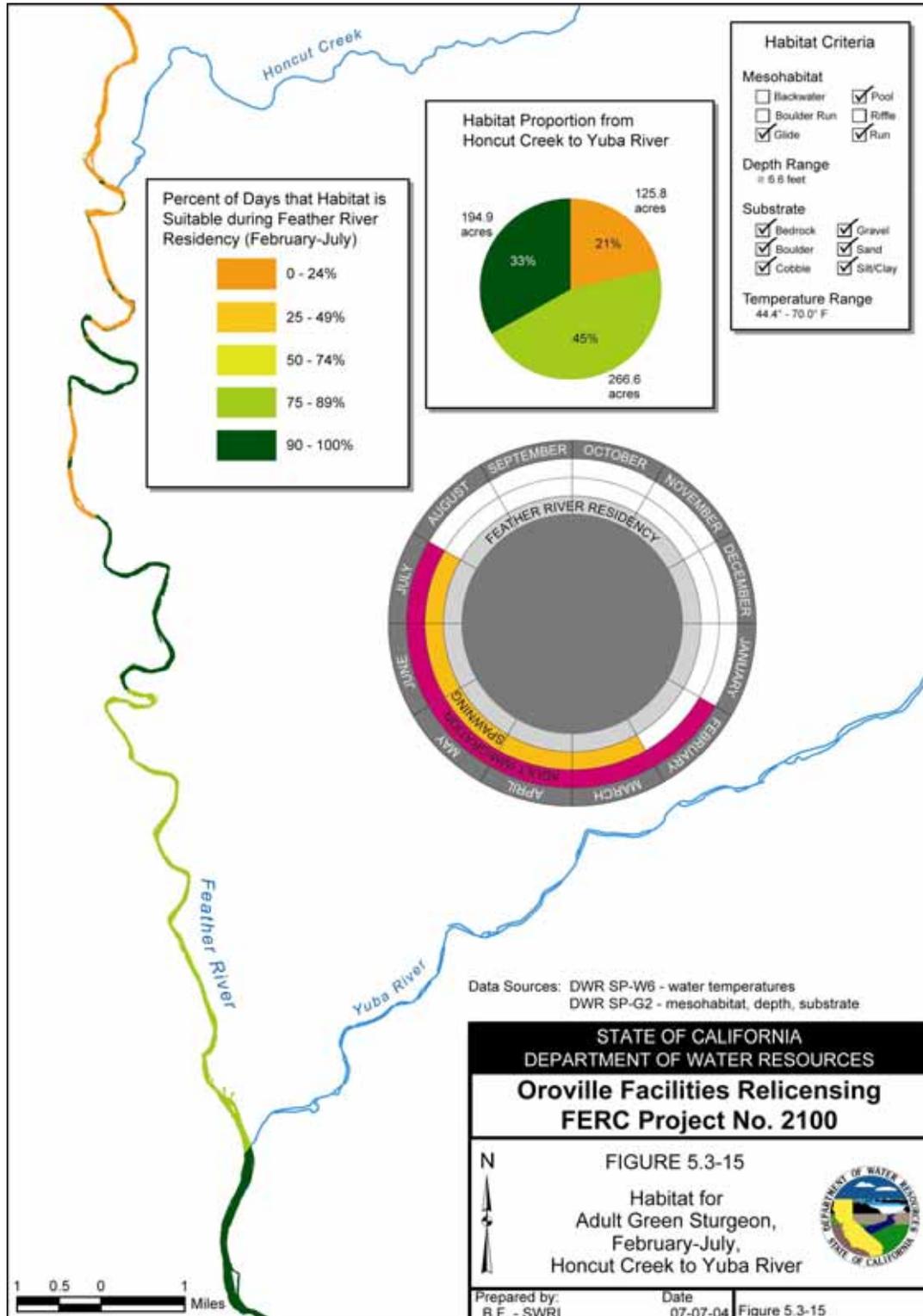


Figure 5.3-15. Green sturgeon habitat in the lower Feather River from Honcut Creek to the Yuba River.

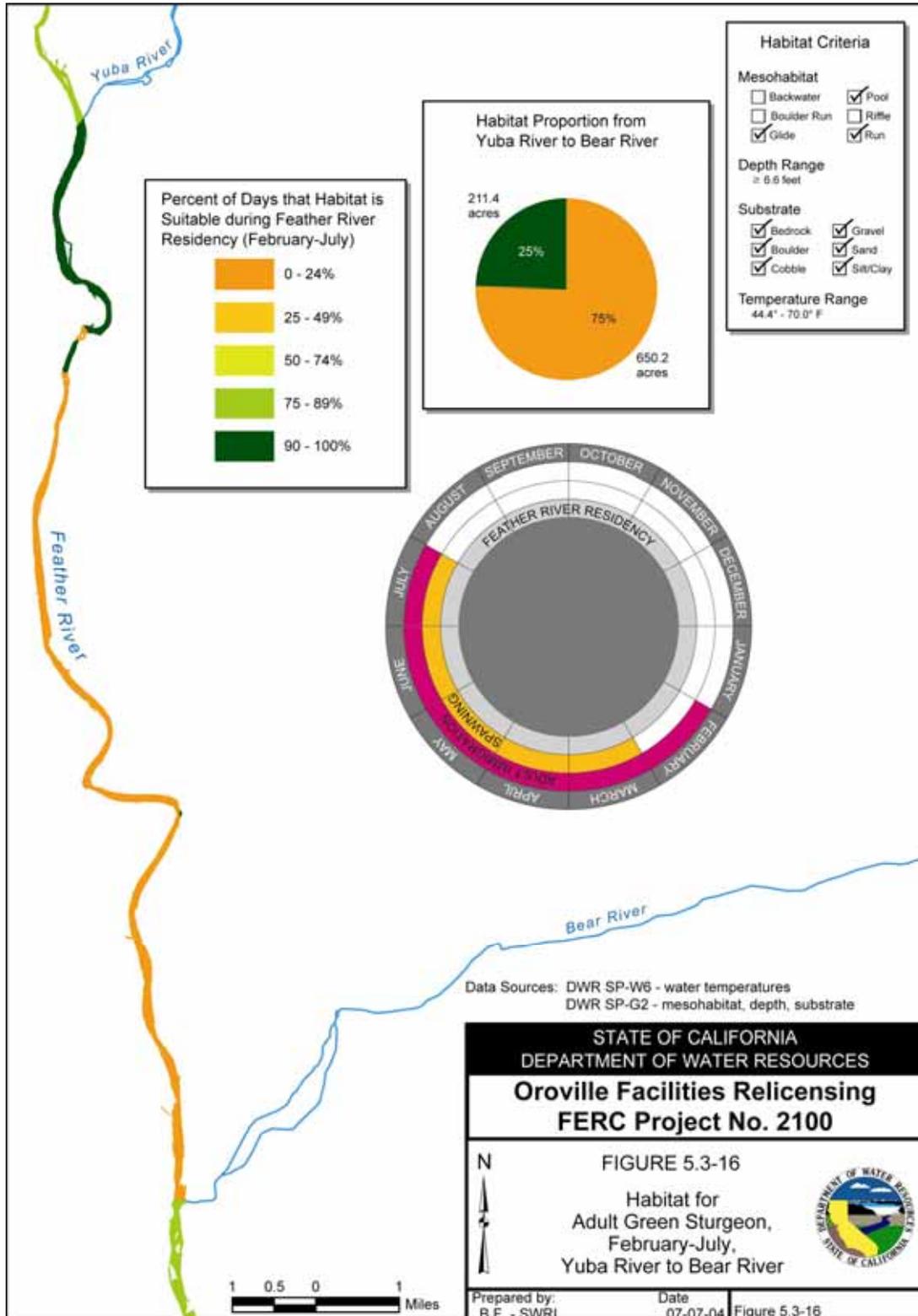


Figure 5.3-16. Green sturgeon habitat in the lower Feather River from the Yuba River to Bear River.

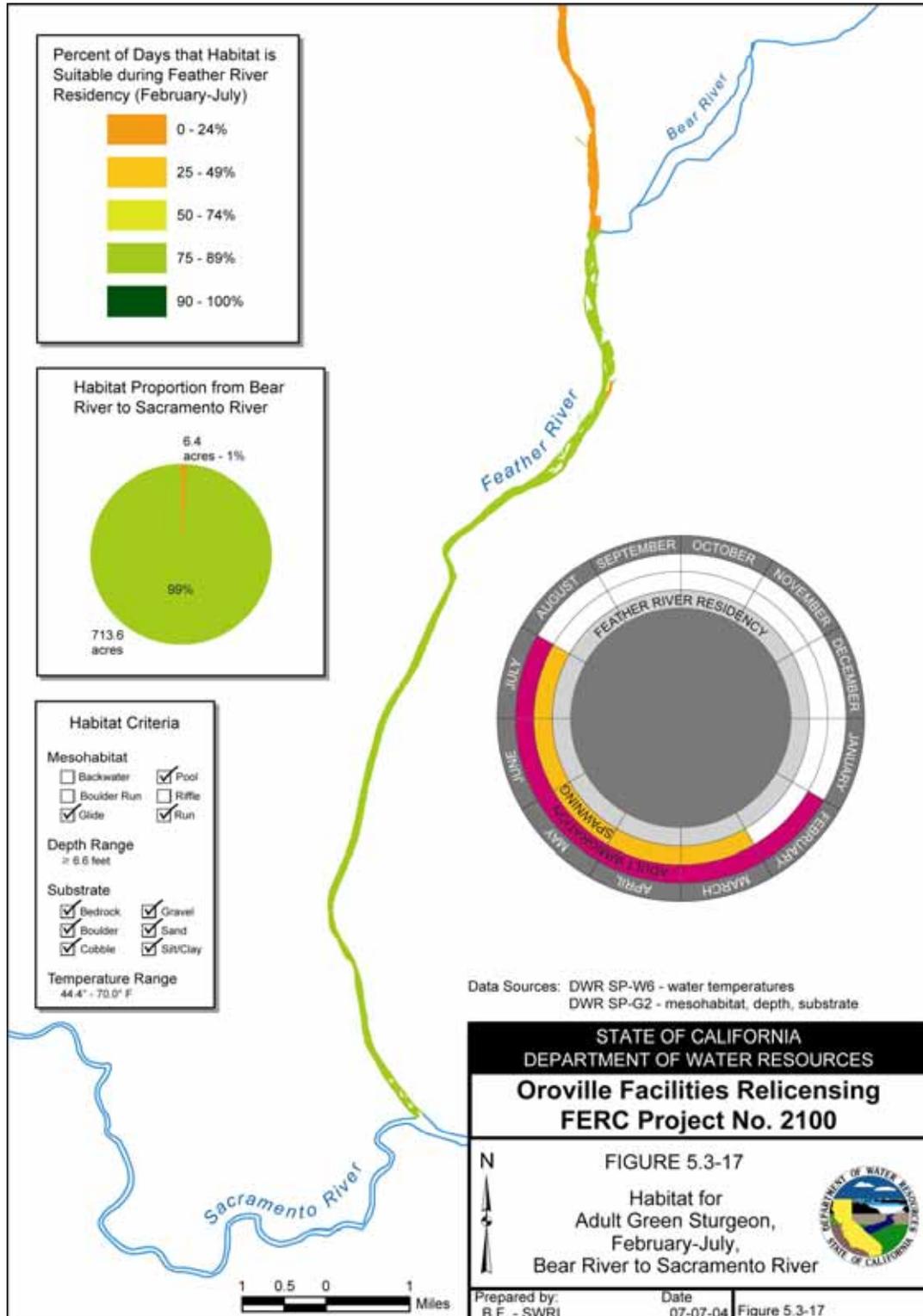
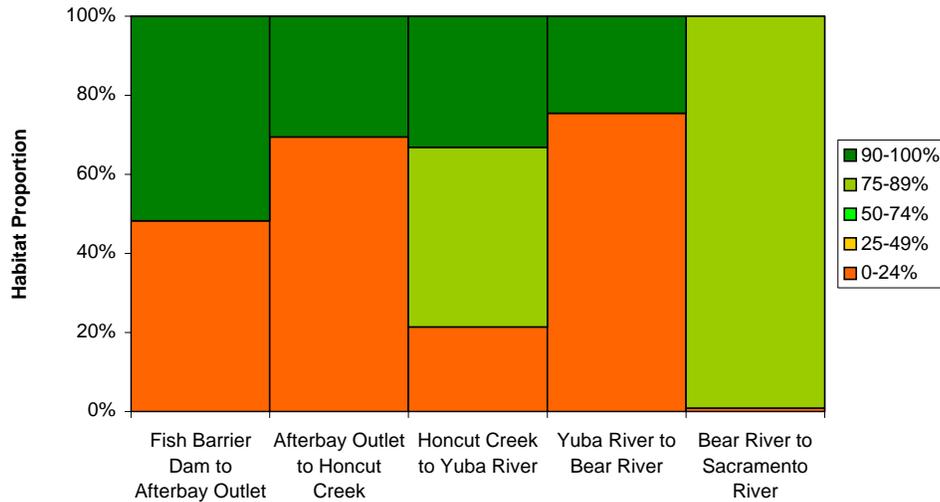


Figure 5.3-17. Green sturgeon habitat in the lower Feather River from the Bear River to the Sacramento River.



**Figure 5.3-18. Proportion of fish habitat and relative habitat suitability for Green Sturgeon by reach in the lower Feather River.**

#### **5.3.1.4 Hardhead and Sacramento Pikeminnow**

Between the Fish Barrier Dam and Honcut Creek, and between the Yuba River and the Feather River confluence with the Sacramento River, 100 percent of the total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figures 5.3-19, 5.3-20, 5.3-22, and 5.3-23).

Between Honcut Creek and the Yuba River, 1 acre (i.e., 0.1 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for hardhead and Sacramento pikeminnow, and 587 acres (i.e., 99 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-21).

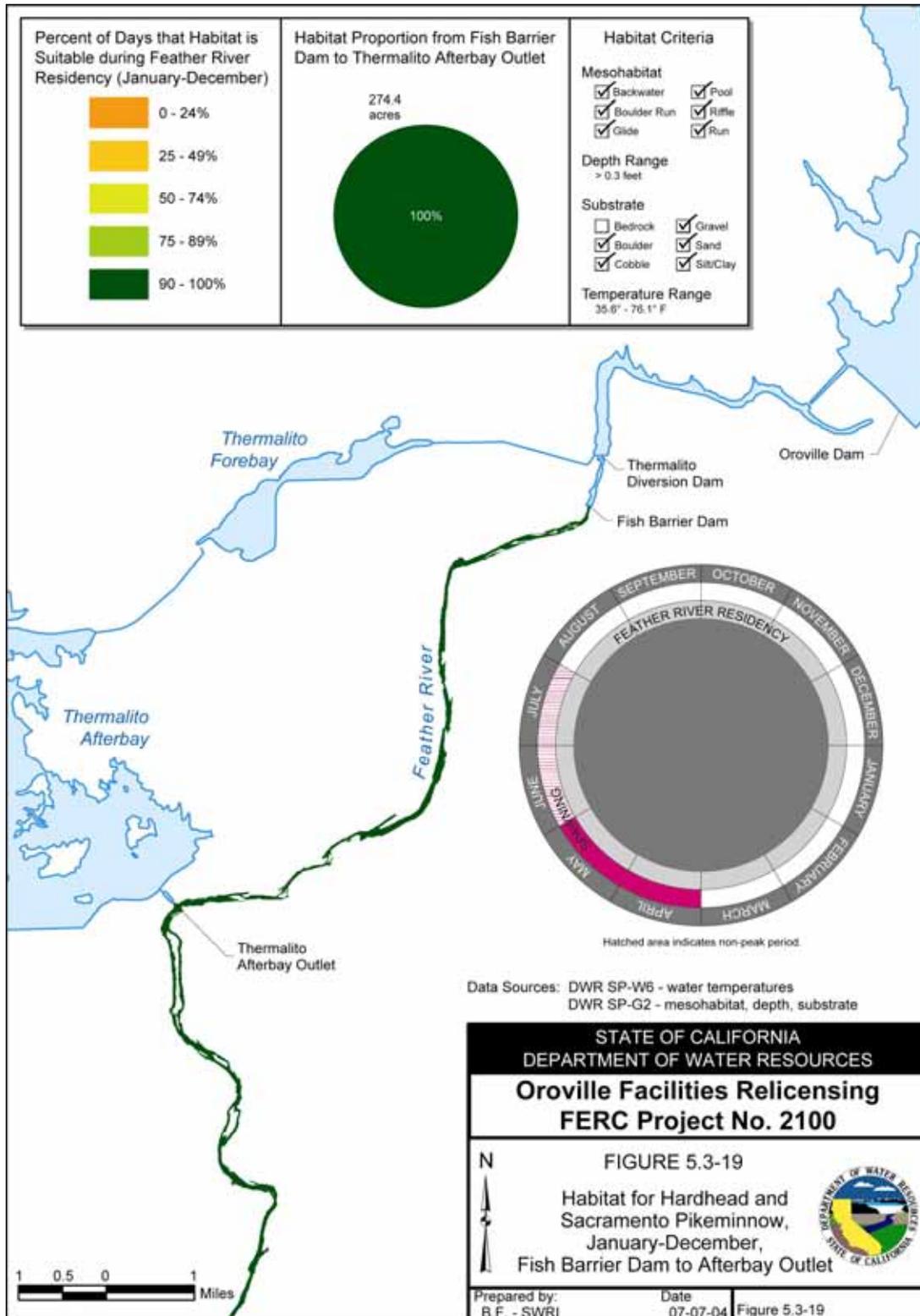


Figure 5.3-19. Hardhead and Sacramento pikeminnow habitat in the lower Feather River from the Fish Barrier Dam to the Afterbay Outlet.

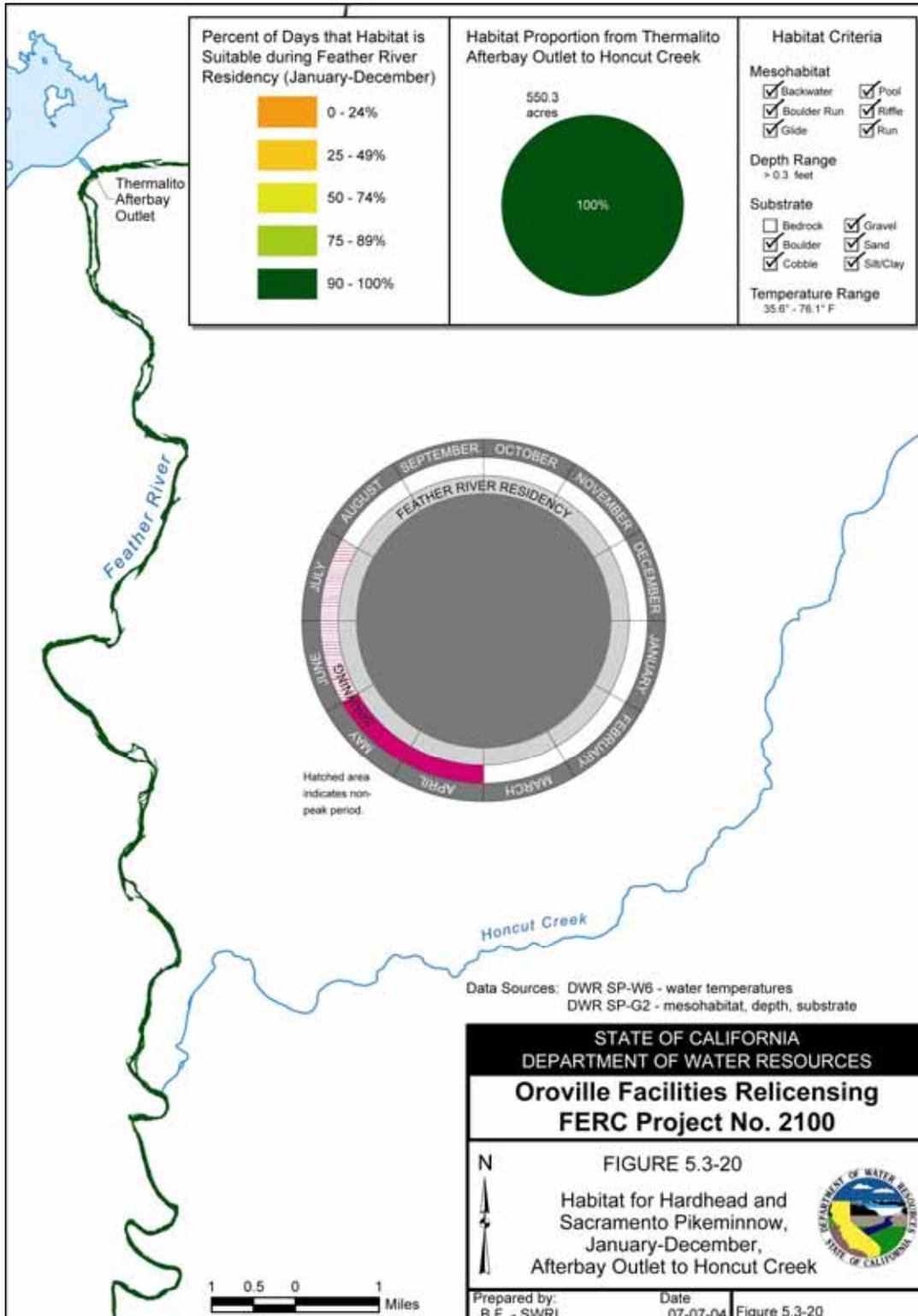


Figure 5.3-20. Hardhead and Sacramento pikeminnow habitat in the lower Feather River from the Afterbay Outlet to Honcut Creek.

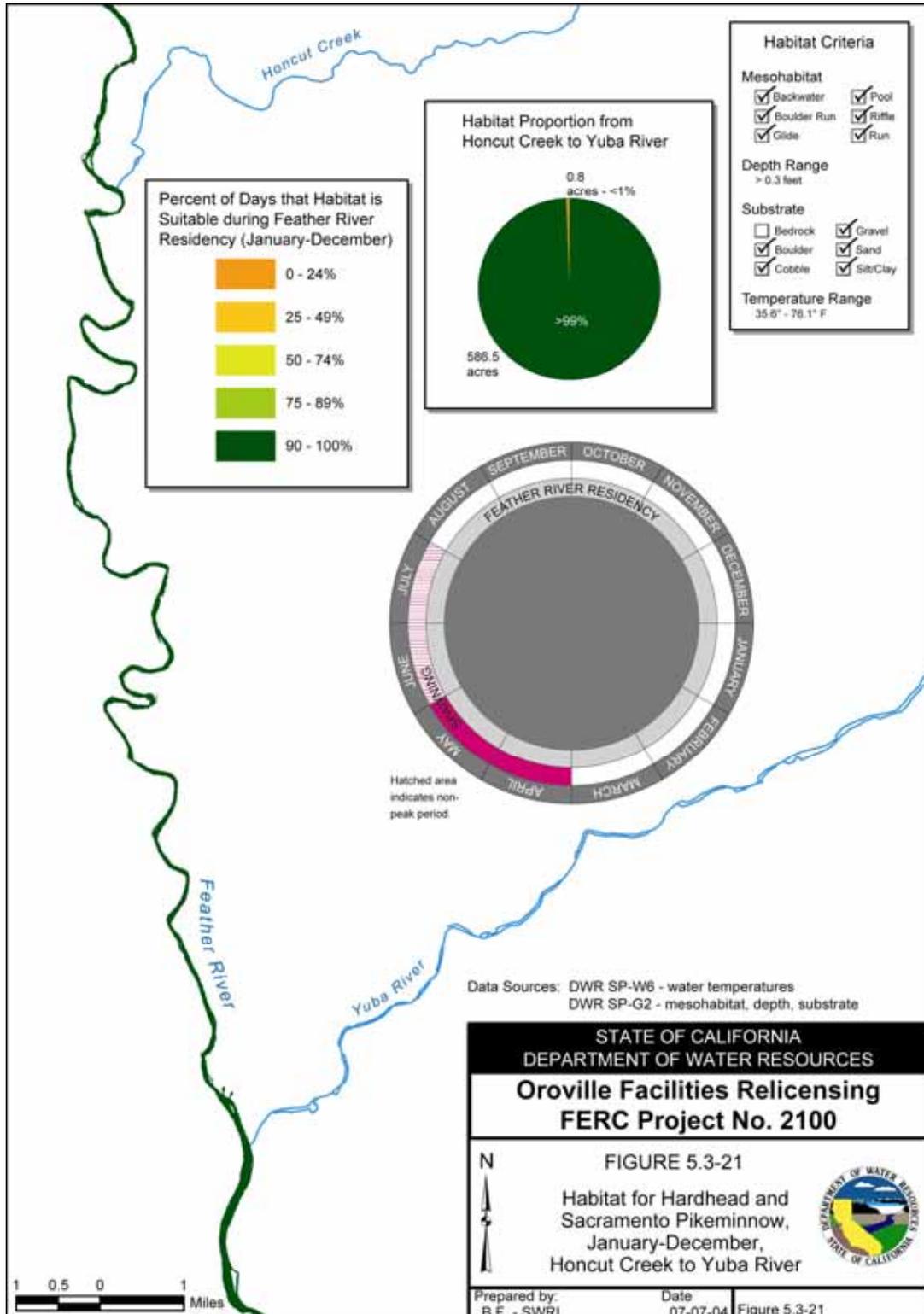


Figure 5.3-21. Hardhead and Sacramento pikeminnow habitat in the lower Feather River from Honcut Creek to the Yuba River.

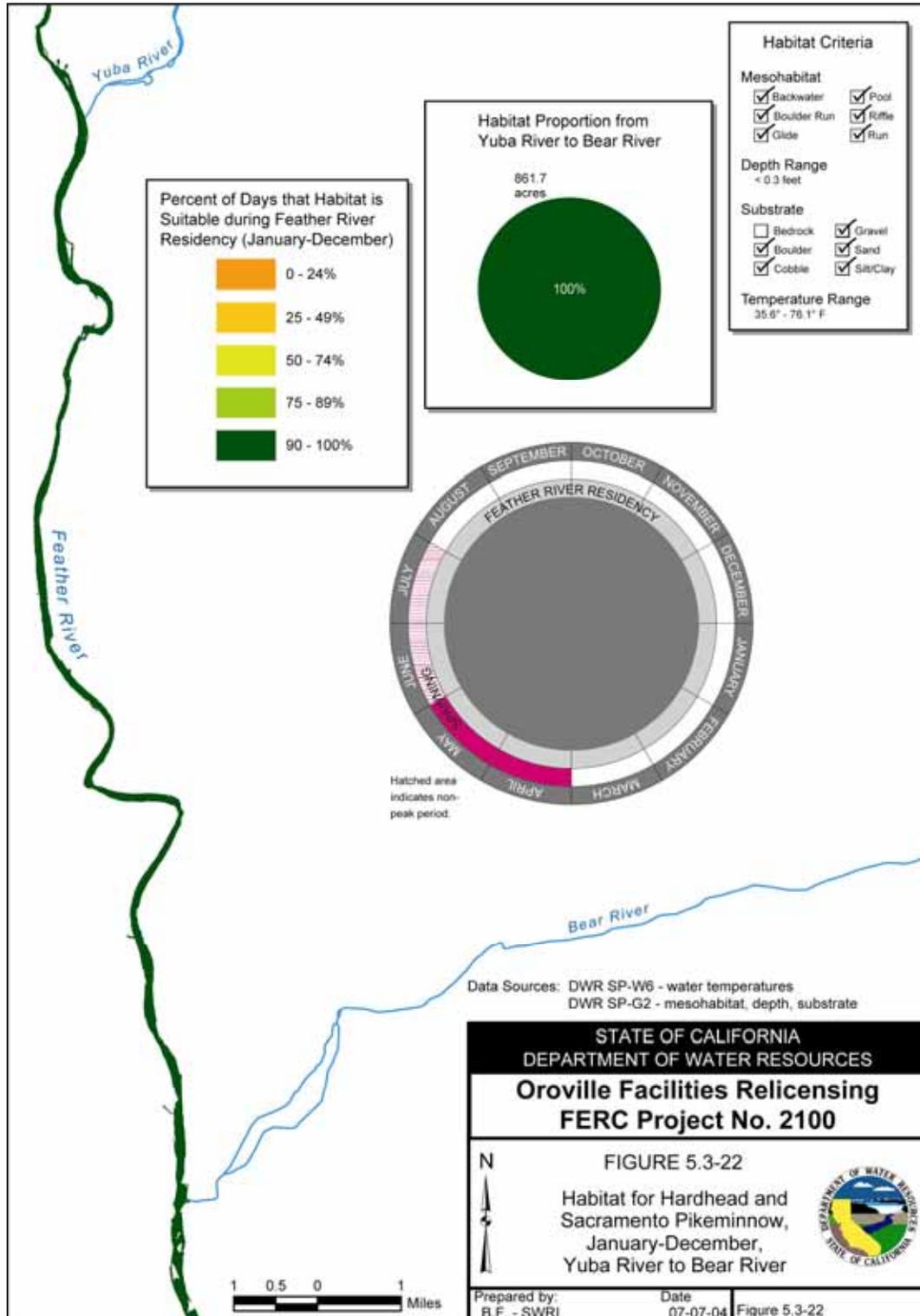


Figure 5.3-22. Hardhead and Sacramento pikeminnow habitat in the lower Feather River from the Yuba River to Bear River.

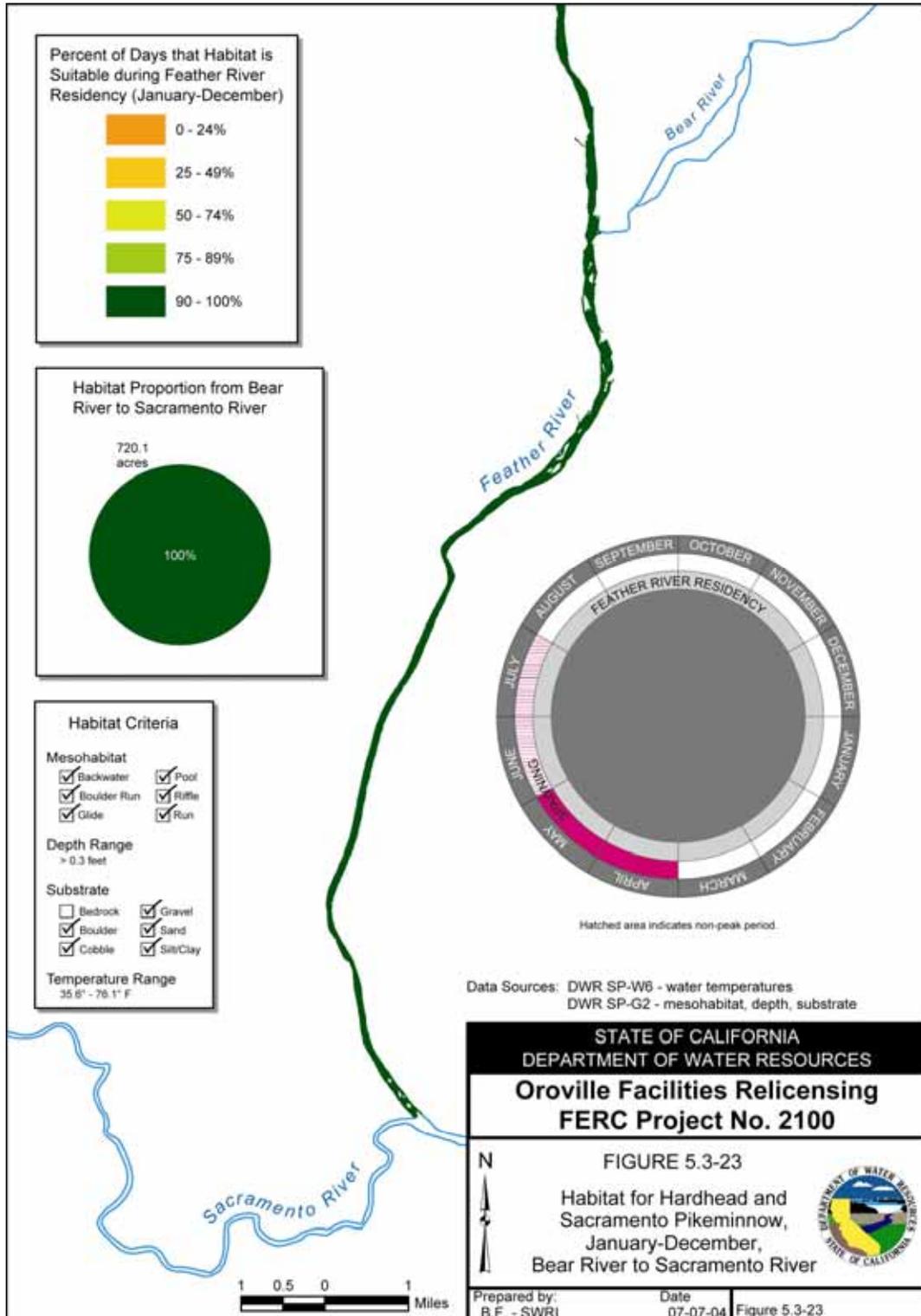
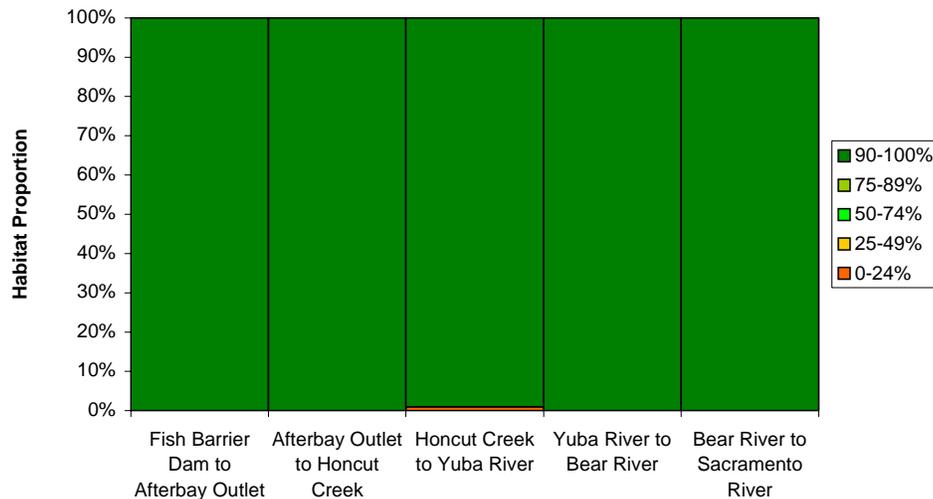


Figure 5.3-23. Hardhead and Sacramento pikeminnow habitat in the lower Feather River from the Bear River to the confluence with the Sacramento River.

The proportion of total available habitat that fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent) for hardhead and Sacramento pikeminnow displayed a relatively homogeneous spatial pattern throughout the lower Feather River. The only exception occurred between Honcut Creek and the Yuba River, where 0.8 acres (i.e., 0.1 percent) of the available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for hardhead and Sacramento pikeminnow. Figure 5.3-24 shows the proportion of habitat and proportion of relative habitat suitability classes for hardhead and Sacramento pikeminnow by reach.



**Figure 5.3-24. Proportion of fish habitat and relative habitat suitability for hardhead and Sacramento pikeminnow by reach in the lower Feather River.**

### 5.3.1.5 Hitch

Between the Fish Barrier Dam and the Thermalito Afterbay Outlet, 50 acres (i.e., 18 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for hitch, and 224 acres (i.e., 82 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-25).

Between the Afterbay Outlet and Honcut Creek, 182 acres (i.e., 33 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for hitch, and 368 acres (i.e., 67 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-26).

Between Honcut Creek and the Yuba River, 20 acres (i.e., 3 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24

percent class) for hitch, and 567 acres (i.e., 97 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-27).

Between the Yuba River and the Bear River, 24 acres (i.e., 3 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for hitch, and 837 acres (i.e., 97 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-28).

Between the Bear River and the Feather River confluence with the Sacramento River, 720 acres (i.e., 100 percent) of total available habitat fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) for hitch (Figure 5.3-29).

The proportion of total available habitat that fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) for hitch generally increased with increasing distance downstream from the Fish Barrier Dam. Specifically, the number of acres of habitat that fell into the 90 percent to 100 percent proportion of relative habitat suitability class increased rapidly downstream from the mouth of Honcut Creek. Figure 5.3-30 shows the proportion of habitat and proportion of relative habitat suitability classes for hitch by reach.

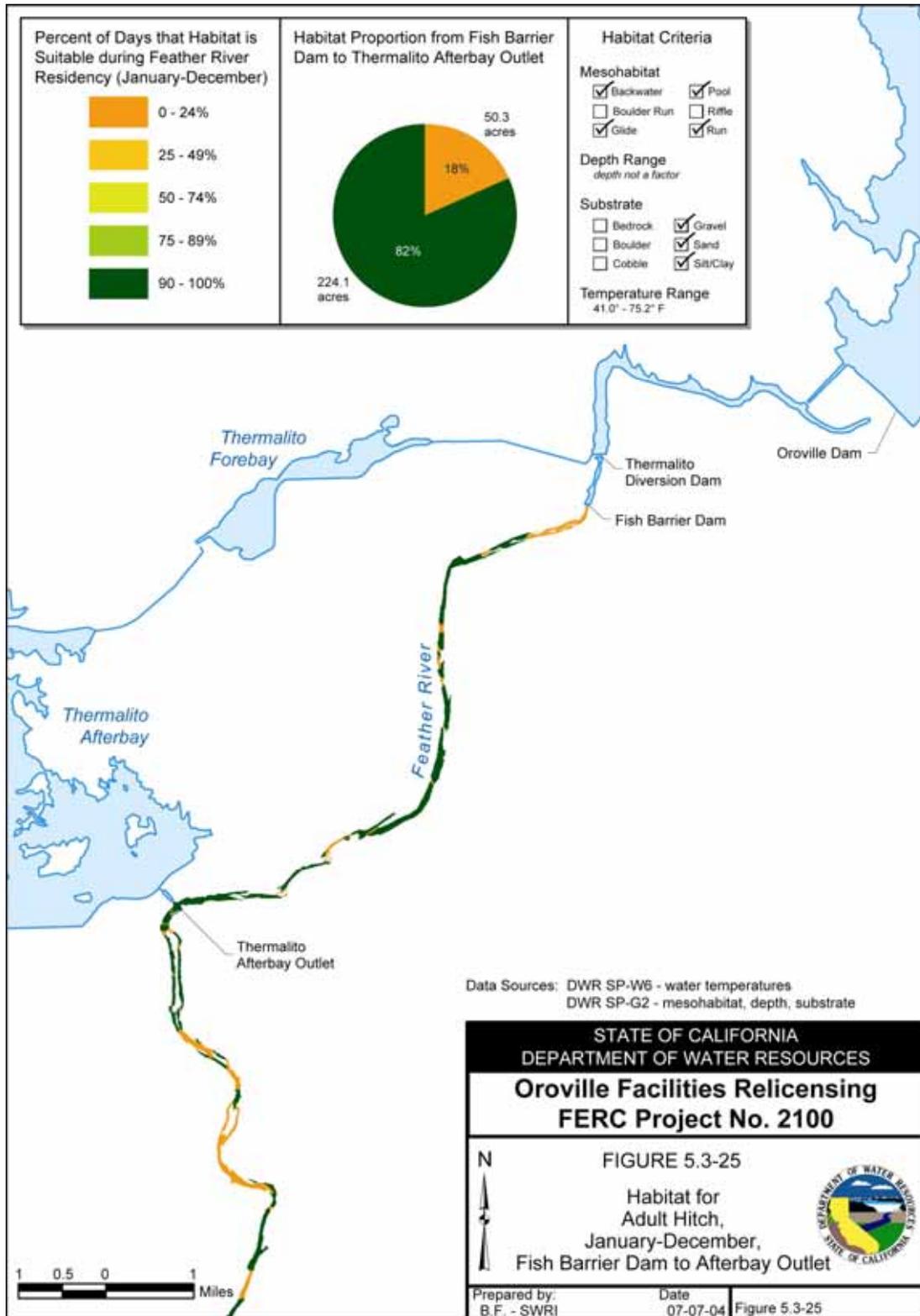


Figure 5.3-25. Hitch habitat in the lower Feather River from the Fish Barrier Dam to the Afterbay Outlet.

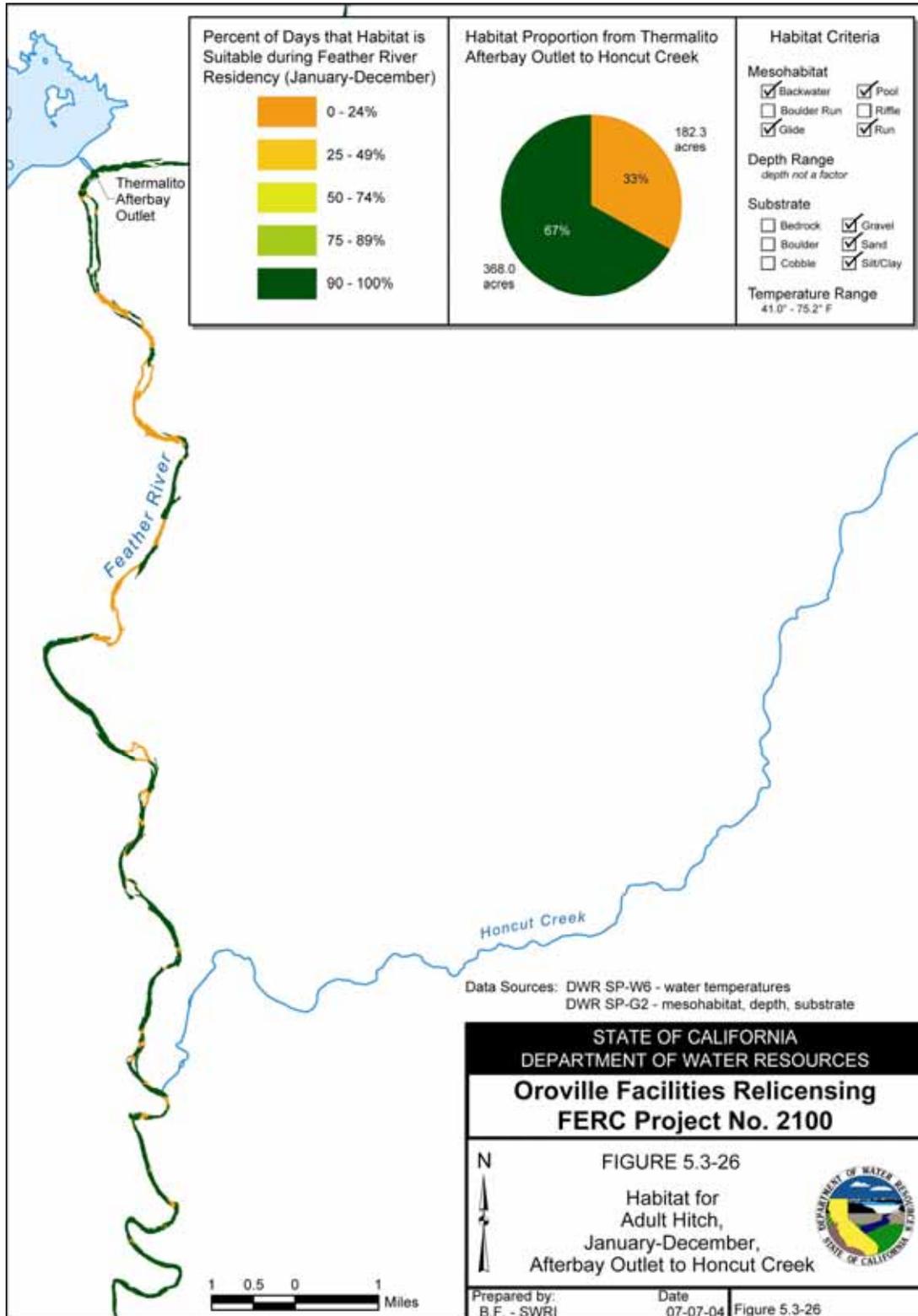


Figure 5.3-26. Hitch habitat in the lower Feather River from the Afterbay Outlet to Honcut Creek.

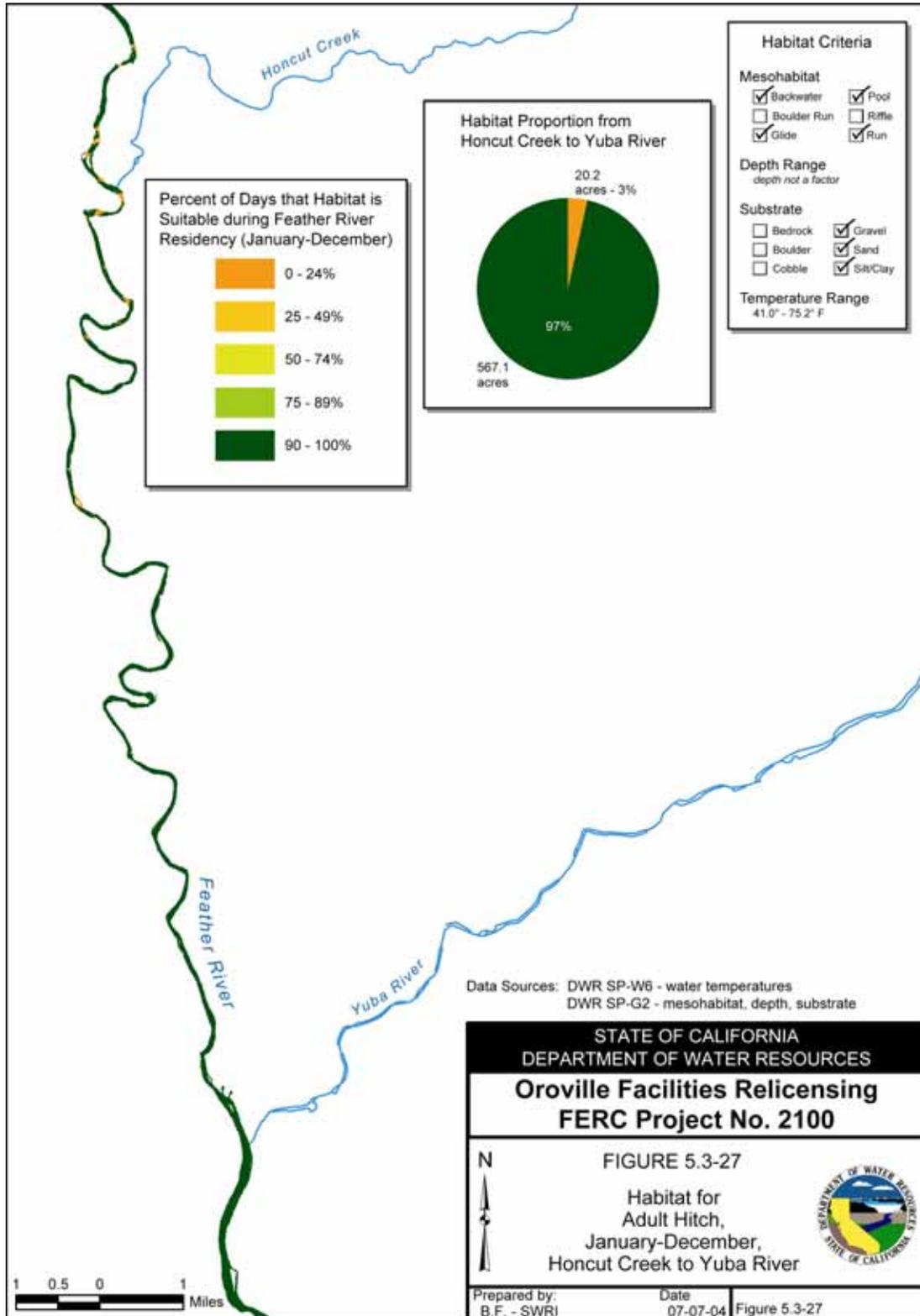


Figure 5.3-27. Hitch habitat in the lower Feather River from Honcut Creek to the Yuba River.

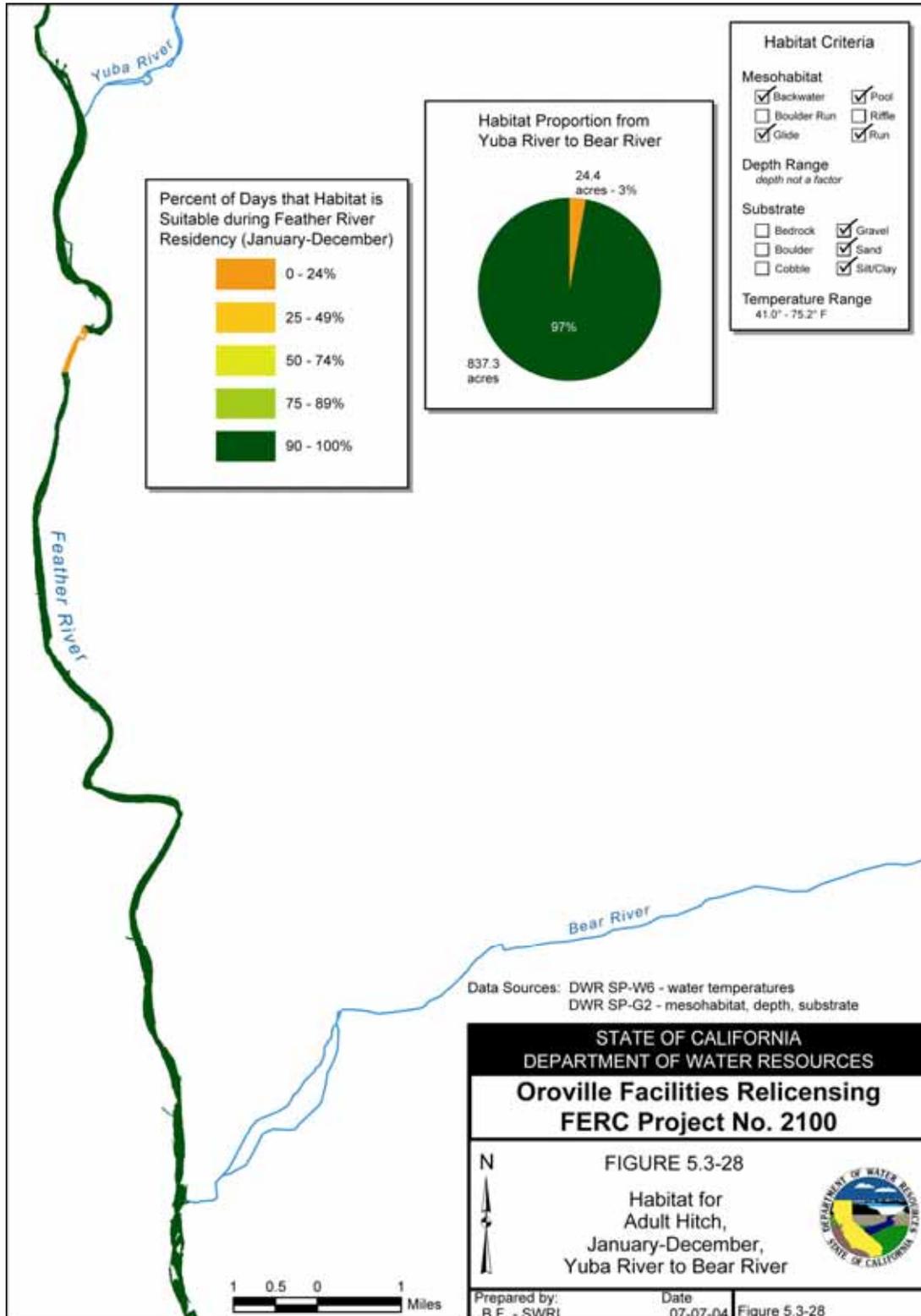


Figure 5.3-28. Hitch habitat in the lower Feather River from the Yuba River to Bear River.

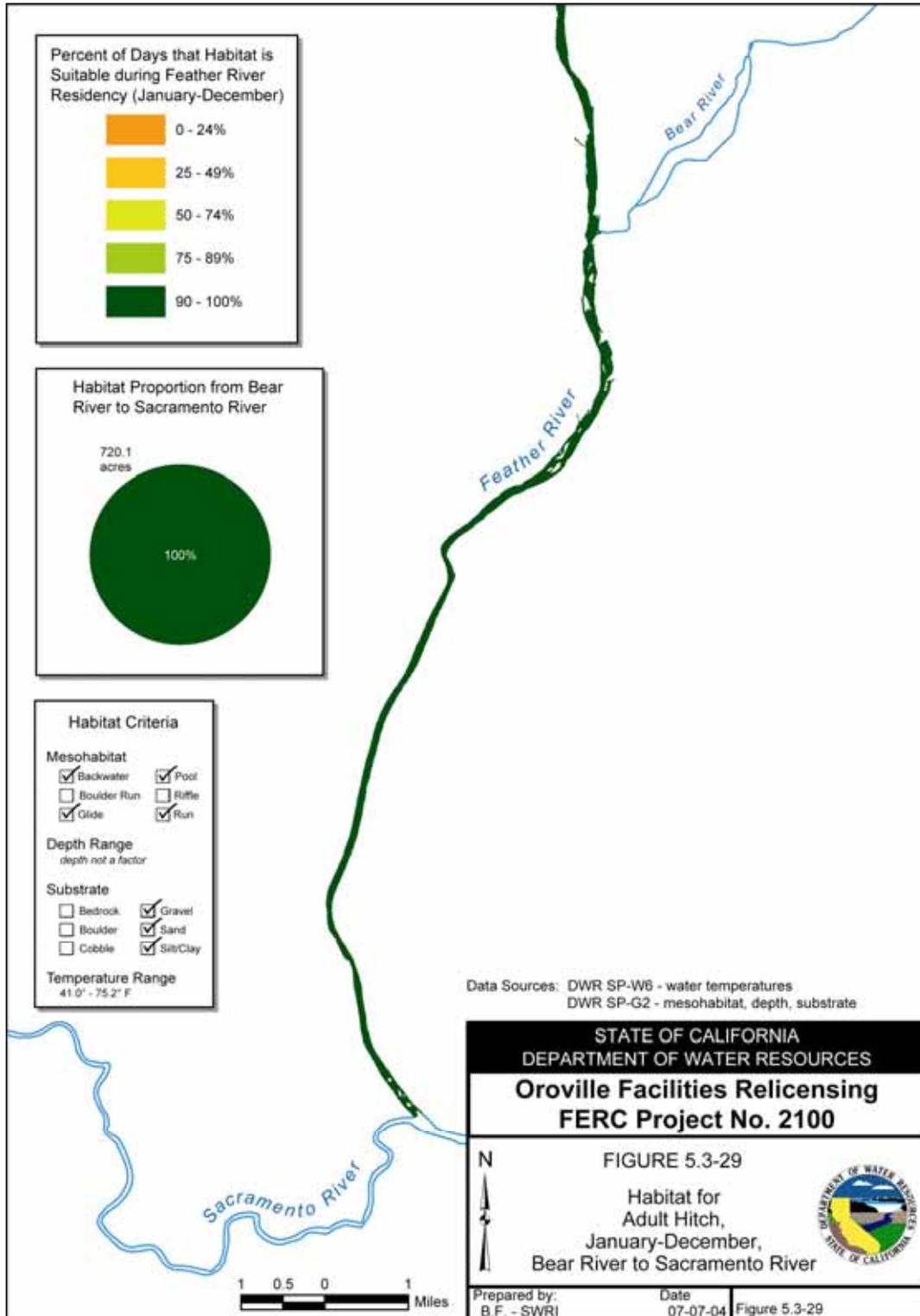


Figure 5.3-29. Hitch habitat in the lower Feather River from the Bear River to the Sacramento River.

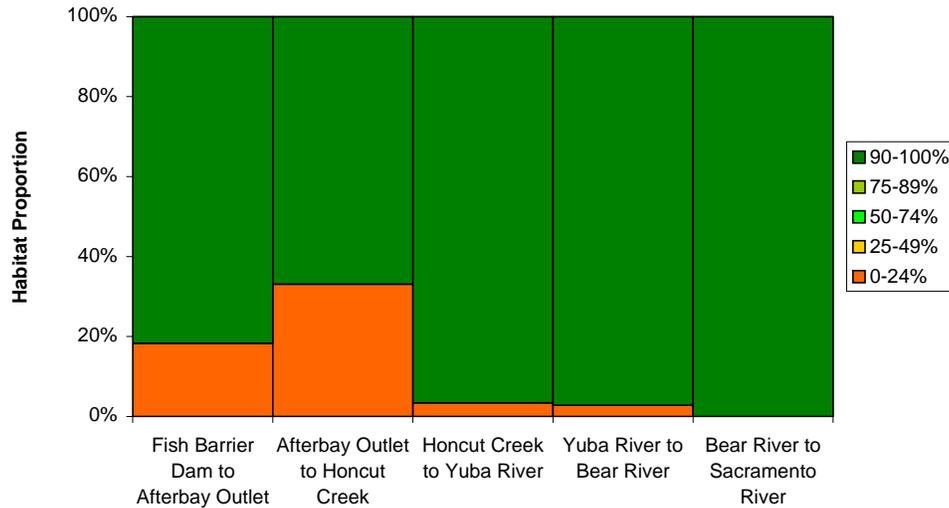


Figure 5.3-30. Proportion of hitch habitat in the lower Feather River by reach.

### 5.3.1.6 Pacific Lamprey

Between the Fish Barrier Dam and the Thermalito Afterbay Outlet, 8 acres (i.e., 3 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Pacific lamprey, 2 acres (i.e., 1 percent) of total available habitat fell into the 50 percent to 74 percent relative habitat suitability class, and 265 acres (i.e., 97 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (90 percent to 100 percent class) (Figure 5.3-31).

Between the Thermalito Afterbay Outlet and Honcut Creek, 6 acres (i.e., 1 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Pacific lamprey, 509 acres (i.e., 93 percent) of total available habitat fell into the 50 percent to 74 percent proportion of relative habitat suitability class, and 36 acres (i.e., 6 percent) of total available habitat fell into the 75 percent to 89 percent proportion of relative habitat suitability class (Figure 5.3-32).

Between Honcut Creek and the Yuba River, 268 acres (i.e., 46 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Pacific lamprey, and 319 acres (i.e., 54 percent) of total available habitat fell into the 25 percent to 49 percent proportion of relative habitat suitability class (Figure 5.3-33).

Between the Yuba River and the Bear River, 4 acres (i.e., 0.4 percent) of total available habitat fell into the lowest proportion of relative habitat suitability class (zero to 24 percent class) for Pacific lamprey, and 858 acres (i.e., 99 percent) of total available

habitat fell into the 25 percent to 49 percent proportion of relative habitat suitability class (Figure 5.3-34).

Between the Bear River and the Feather River confluence with the Sacramento River, 720 acres (i.e., 100 percent) of total available fell into the lowest proportion of relative habitat suitability class (90 percent to 100 percent class) for Pacific lamprey (Figure 5.3-35).

A small proportion of total available habitat for Pacific lamprey fell into the highest proportion of relative habitat suitability class (90 percent to 100 percent class) and only occurred in the most upstream reach of the lower Feather River upstream from the Thermalito Afterbay Outlet. Increasing proportions of habitat downstream from the Thermalito Afterbay Outlet decreased in relative habitat suitability. The reaches between the Yuba River and the Bear River, and the Bear River to the Feather River confluence with the Sacramento River predominantly fell into the 25 percent to 49 percent, and zero to 24 percent proportion of relative habitat suitability classes, respectively. Figure 5.3-36 shows the proportion of habitat and proportion of relative habitat suitability classes for Pacific lamprey by reach.