3.3.3 Aquatic Resources

The discussion of aquatic resources is divided into five sections. The affected environment is discussed in Section 3.3.3.1, environmental effects of the Proposed Project are discussed in Section 3.3.3.2, cumulative effects are described in Section 3.3.3.3, unavoidable adverse effects are addressed in Section 3.3.3.4, and measures recommended by agencies and other interested parties in written comments on SSWD's DLA that were not adopted by SSWD are discussed in Section 3.3.3.5.

SSWD augmented existing, relevant, and reasonably available information with four relicensing studies: 1) Study 3.1, *Salmonid Redd Study*; 2) Study 3.2, *Stream Fish Populations Study;* 3) Study 3.3, *Instream Flow Study;* and 4) Study 3.4, *Benthic Macroinvertebrate Study*. The studies are complete, and information on the study results can be found in this Application for New License. Additionally, data related to each study are located in Appendix E1 in Exhibit E of this Application for New License.

3.3.3.1 Affected Environment

This section describes the condition of existing aquatic resources in three general areas: 1) special-status aquatic species, 2) aquatic invasive species, and 3) aquatic resources of the Bear River.

3.3.3.1.1 Special-Status Aquatic Species

Four special-status aquatic species occur or have been reported to occur recently in the Project Area. These are: 1) Central Valley (CV) fall-run Chinook salmon Evolutionarily Significant Unit (ESU) (NMFS-S, CSC); 2) white sturgeon (CSC); 3) Sacramento-San Joaquin roach (CSC); and 4) Western (or northwestern) pond turtle (*Actinemys marmorata*) (CSC). Two other species - hardhead (CSC) and Sacramento splittail (*Pogonichthys macrolepidotus*) (CSC) – have been reported in the area, but have not been documented in recent times. A seventh species - foothill yellow-legged frog (*Rana boylii*) (CSC, CESA Candidate Species) - has never been reported to occur in the Project area and is found above elevations of 600 feet, but it is included here because it is a Candidate for listing under CESA and known extirpated populations once occurred at elevations below 300 ft in some areas (Moyle 1973; Seltenrich and Pool 2002; ECORP 2005). A description of each of these seven species, including its nearest known occurrence to Project facilities and features, is provided below.

Central Valley fall-run Chinook salmon ESU (NMFS-S, CSC)[1]

Four principal life history variants of Chinook salmon are recognized in the California Central Valley and are named for the timing of their spawning runs: fall-run, late fall-run, winter-run, and spring-run.

[1] Photo source: http://www.usgs.gov/features/lewisandclark/images/Chinook_Salmon.jpg

Seventeen distinct groups, or ESUs, of naturally-spawned Chinook salmon occur from southern California to the Canadian border and east to the Rocky Mountains; five of these groups occur in California (Myers et al. 1998). Four groups occur in the Project Vicinity (NMFS 2008), but only the CV fall-run ESU has been documented in the lower Bear River. NMFS listed CV fall-run Chinook salmon ESU as a Species of Concern in 2004 due to concerns about population size and hatchery influence (NMFS 2009). Little information exists regarding the life history of CV Chinook salmon ESU in the lower Bear River. Therefore, much of the information in this section is based on the life history of CV fall-run Chinook salmon ESU in the lower Yuba and Feather rivers. The Bear and Yuba rivers are both tributaries to the Feather River. Therefore, it is anticipated that the life history and timing of CV fall-run Chinook salmon ESU in the Bear River are similar to that seen of the Feather and Yuba rivers.

Although it is an important commercial and recreational fish species, declines in populations resulted in harvest management restrictions throughout California. In April 2009, the Pacific Fishery Management Council and NMFS adopted a closure of all commercial ocean salmon fishing through April 30, 2010, and placed restrictions on inland salmon fisheries over the same time frame (CDFG 2009a). Currently the Bear River from the non-Project diversion dam to Highway 65 is only subject to sport fishing regulations, which is annually open from the fourth Saturday in May through October 15.

The generalized life history of Pacific salmon (*Oncorhynchus* sp.) involves spawning, incubation, hatching, emergence, and rearing in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of the life-cycle (Myers et al. 1998).

Chinook salmon is the largest salmonid, with adults often exceeding 40 pounds, and individuals over 120 pounds reported (NMFS 2008). Adult Chinook salmon migrate from the ocean into the freshwater streams and rivers of their birth to mate (i.e., anadromy) and, following a single spawning event, they die (i.e., semelparity). Adult CV fall-run Chinook salmon ESU generally begin migrating upstream in the Feather River annually in June, with immigration continuing through December (Moyle 2002; NMFS 2008). In the Central Valley, immigration generally peaks in November and, typically, greater than 90 percent of the run has entered their natal river by the end of November (Moyle et al. 2008).

The timing of adult Chinook salmon spawning activity is influenced by water temperatures. In general, when mean daily water temperatures decrease to approximately 60°F, female Chinook salmon begin to construct nests, which are known as redds, into which their eggs are eventually released and simultaneously fertilized by males (Moyle 2002; NMFS 2008). Chinook salmon require gravel and cobble areas, primarily at the heads of riffles, with water flow through the substrate for spawning. Gravel and cobble sizes can range from 0.1 to 6 in in diameter. Fall-run Chinook salmon spawning and embryo incubation period generally extends from October through March, but may occur earlier if temperature conditions fall below 60°F (Moyle 2002; NMFS 2008). Based on life history periodicities in the Feather and Yuba rivers, CV fall-run Chinook salmon ESU fry emergence is expected to typically occur from late December through March within the Project Vicinity (Moyle 2002). Growth rates are largely influenced by water temperature, and the optimal range of juvenile rearing temperatures is 55° through 65°F. Young

Chinook salmon will survive and grow within the range of 41°F through 66°F, but steady temperatures above 75°F are lethal (UC Davis 2018).

Table 3.3.3-1 shows the CV fall-run Chinook salmon ESU lifestage periodicity developed by the Lower Yuba River Accord Management Team for the lower Yuba River (RMT 2013). SSWD expects that the lower Yuba River and lower Bear River CV fall-run Chinook salmon ESU periodicities are generally similar. The lower Yuba River is a larger basin than the Bear River, so select areas may extend beyond the suitable periods of the lower Bear River.

Table 3.3.3-1. Life stage-specific periodicities for CV fall-run Chinook salmon ESU in the Yuba River. Reproduced from Lower Yuba River Accord River Management Team (2013). Gray shading is assumed presence.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Adult Immigration & Staging																								
Spawning																								
Embryo Incubation																								
Fry Rearing																								
Juvenile Rearing																								
Juvenile Downstream Movement																								

In addition, water temperature is very important for the support of CV fall-run Chinook salmon ESU in the lower Bear River. In 1991, using multiple sources of information, CDFG (1991) opined ranges of preferred water temperatures for each life stage of CV fall-run Chinook salmon ESU. Table 3.3.3-2 provides the CDFG preferred water temperature by life stages, including the sources cited by CDFG.

Table 3.3.3-2. CDFG 1991 water temperatures for CV fall-run Chinook salmon life stages.

CV Fall-Run Chinook Salmon Life Stage	Preferred Water Temperature Range (°C)	Sources Cited by CDFW
Upstream Migration	6.7° to 14.2°C	Bell 1986, Rich 1987
Spawning	5.0° to 13.9°C	Reiser and Bjornn 1979, Rich 1987, and Chambers 1956
Egg Incubation through Fry Emergence	5.0° to 14.4°C	Reiser and Bjornn 1979, and Rich 1987
Fry Rearing	7.0° to 14.0°C	Raleigh et al. 1986 and Rich 1987
Juvenile Rearing	7.3° to 14.6°C	Reiser and Bjornn 1979, and Rich 1987

In its 1991 report, CDFG stated that warm water temperatures near the confluence of the lower Bear and Feather rivers during September and October could delay CV fall-run Chinook salmon ESU upstream migration into the Bear River. The report concluded that the preferred water temperature range for spawning was exceeded at Wheatland until early November, thereby shortening the period for spawning that is normally October through January. CDFG also concluded that during the incubation period of October through February, water temperatures generally exceed the optimum only during October and that the temperature range for juvenile rearing was exceeded during the entire rearing period of April through June.

More recently, CDFW and other federal and state agencies have expressed a reliance on salmon and steelhead life history water temperature guidelines developed by the United States Environmental Protection Agency (EPA 2003). These guidelines are 7-day averages of the daily maxima (7DADM) water temperatures that the EPA claims will maintain protection of anadromous salmonids. The EPA-developed guidelines are based on a review of literature describing water temperature-related effects on various species of anadromous salmonids. The EPA did not develop guidelines based on local testing and some guidelines were applied to multiple species of salmonids (e.g., *O. mykiss* and Chinook salmon). Further, the EPA (2003) does not distinguish between ESUs or DPS' of conspecific anadromous salmonids (e.g., spring-run and fall-run Chinook salmon), and the EPA water temperature guidelines do not align directly with the Chinook salmon periodicities in Table 3.3.3-1. Table 3.3.3-3 shows the EPA guidelines for the anadromous salmonid lifestages.

Table 3.3.3-3. EPA water temperature guidelines (EPA 2003) for protection of anadromous salmonids by life stage.

Salmonid Life History Phase Terminology	7-Day Average of the Daily Maxima Guideline (°C)	Intended Period of Protection
Adult and Juvenile Migration	≤18°C	Salmon and steelhead migration
Spawning and Egg Incubation	≤13°C	Salmon and steelhead spawning, egg incubation and fry emergence
Juvenile Rearing	≤16°C for "core" juvenile rearing;[1]	Salmon and steelhead rearing and
Smoltification	≤14°C	Composite criteria for salmon and steelhead smoltification[2]

[1] The EPA recommends that for areas of degraded habitat, "*core juvenile rearing*" use cover the downstream extent of low density rearing that currently occurs during the period of maximum summer temperatures (EPA 2003).

[2] The EPA establishes a guideline of ≤15°C for salmon smoltification and a guideline of less than or equal to 14°C for steelhead smoltification; but for a composite guideline for both species, the steelhead guideline of less than or equal to 14°C is applied.

The EPA recommends its guidelines because they "*describe the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day*." The EPA states that, because this metric uses daily maximum water temperatures, the guidelines can be used to protect against acute water temperature effects (EPA 2003). The EPA also states that its guidelines can be used to protect against sub-lethal or chronic effects, but the cumulative thermal exposure of fish over the course of a week or more needs to be considered when selecting a 7DADM value to protect against these effects (EPA 2003). Based on studies of fluctuating water temperature regimes, the EPA concludes that:

> ...fluctuating temperatures increase juvenile growth rates when mean temperatures are colder than the optimal growth temperature derived from constant temperature studies, but will reduce growth when the mean temperature exceeds the optimal growth temperature. When the mean temperature is above the optimal growth temperature, the "mid-point" temperature between the mean and maximum is the "equivalent" constant temperature. This "equivalent" constant temperature then can be directly compared to laboratory studies done at constant temperatures. For example, a river with a 7DADM value of 18°C and a 15°C weekly mean temperature (i.e., diurnal variation +/- 3°C) will be roughly equivalent to a constant laboratory study temperature of 16.5°C (mid-point between 15°C and 18°C). Thus, both maximum and mean temperatures are important when determining a 7DADM value that is protective against sub-lethal/chronic effects.

Because the 7DADM water temperature guideline is reportedly about 3°C higher than the weekly mean water temperature in many rivers in the Pacific Northwest (Dunham et al. 2001 and Chapman 2002, both as cited in EPA 2003), EPA (2003) said it first started with the constant temperatures that scientific studies indicate would be protective against chronic effects, and then added 1-2°C to develop 7DADM temperatures that would protect against chronic effects.

Table 3.3.3-4 provides a crosswalk between the Yuba River Chinook salmon periodicities and the EPA water temperature guidelines.

Table 3.3.3-4. Life history events for Yuba River Periodicity, EPA (2003) temperature guidelines, and instream flow life history variables merged into a single 12-month calendar for comparative reference.

Yuba River Periodicity[1]	EPA (2003) Water Temp[2]	Instream Flow[3]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Immigration & Staging	Adult Migration	Spawning												
Spawning	Spawning and Egg Incubation													
Embryo Incubation														
Fry Rearing	Juvenile Rearing	Fry Rearing												
Juvenile Rearing		Juvenile Rearing												
Juvenile Downstream Movement	Smoltification													

[1] As provided in Table 3.3.3-1 of this Exhibit E.
[2] As provided in Table 3.3.3-3 of this Exhibit E.
[3] As discussed in Section 3.3.1.3 of this Exhibit E.

In the Central Valley, fall-run Chinook salmon ESU are the most numerous of the four salmon runs and are the principal run raised in hatcheries (Moyle 2002). Throughout the Central Valley, the number of Chinook salmon returning in the fall to spawn has exhibited a declining trend in recent years based on data reported in GrandTab.[2] Little is known about the historical run size, but it has been reported to be highly variable from year to year depending on fall flow conditions.

Fall-run Chinook salmon are raised at five major Central Valley hatcheries that release more than 32 million smolts each year into California water bodies (CDFG 2007). Chinook salmon fry stocking occurred in the Bear River in 1981, 1983, 1985, 1986, and 1987. Stocking typically occurred at Patterson's Gravel Plant (RM 16). Each year roughly 100,000 Feather River or Nimbus Hatchery fall-run fry were released into the river. No known plantings of Chinook salmon fry in the lower Bear River have occurred since 1987. Recently, Chinook salmon have been released in the Feather River at the Hatchery and near Live Oak (RMIS 2015).

While hatchery programs can increase overall returns to the fishery, Lindley et al. (2007) concluded that hatchery programs have negative effects on wild populations of Chinook salmon

[2] GrandTab is a compilation of annual population estimates for Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento and San Joaquin River systems. GrandTab is available for download at: http://www.calfish.org/IndependentDatasets/CDFGFisheriesBranch/tabid/157/Default.aspx

due to competition by hatchery fish with wild juveniles, and straying of hatchery fish both within and between basins and resultant introgression of hatchery stocks with native populations.

Unlike spring-run Chinook salmon, adult fall-run Chinook salmon does not exhibit an extended over-summer holding period. Rather, it stages for a relatively short period of time prior to spawning. Adult CV fall-run Chinook salmon ESU immigration and staging has been reported to generally occur in the nearby lower Yuba River from August through November (CALFED and YCWA 2005).

Fall-run Chinook salmon embryo incubation extends from the time of egg deposition through alevin emergence from the gravel. The CV fall-run Chinook salmon ESU embryo incubation period has been reported to extend from October through March in the lower Yuba River (YCWA et al. 2007).

In the Central Valley, fall-run Chinook salmon ESU fry emergence generally occurs from late-December through March (Moyle 2002). CV fall-run Chinook salmon ESU juvenile rearing and outmigration in the lower Yuba River has been reported to primarily occur from December through June (CALFED and YCWA 2005; SWRI 2002). In the lower Yuba River, most CV fall-run Chinook salmon ESU exhibit downstream movement as fry shortly after emergence from gravels, although some individuals rear in the river for a period of up to several months and move downstream as juveniles. Thus, the fry rearing lifestage is considered to extend from December through April, and the juvenile rearing lifestage from January through June.

The Bear River has historically contained a single run of fall-run Chinook salmon (Yoshiyama et al. 2001). Adult salmon historically ascended as far as a barrier waterfall in the immediate vicinity of Camp Far West Dam (Yoshiyama et al. 2001). No waterfall currently exists in the area so it has presumably been inundated by the construction of the dam and formation of the reservoir (Yoshiyama et al. 2001). There are no known accounts of anadromous fishes of any kind upstream of the original barrier waterfall. Yoshiyama et al. (2001) estimates that less than 1 RM of salmon habitat was lost due to the creation of Camp Far West Dam. USFWS (1998) states:

> Historically, the Bear River never supported substantial runs of salmon and steelhead as a consequence of its naturally intermittent hydrology and the occurrence of a natural rock barrier located a short distance upstream from Camp Far West Reservoir. This barrier prevented salmon and steelhead from ascending the Bear River to higher elevations where streamflows and water temperatures were more suitable. Thus, fish were restricted to the Sacramento Valley floor where environmental conditions were not always favorable. In years with favorable flows, the Bear River probably supported small runs of fall-run Chinook salmon and steelhead, although run size estimates are not available.

Reports issued in 1991 and 1993 by CDFG (1991) and Reynolds et al. (1993) respectively, stated that fall flows, specifically October and November, in the lower Bear River appeared to influence the CV fall-run Chinook salmon ESU run size. During years of high water in October and November, CDFG reports runs as high as 300 CV fall-run Chinook salmon ESU in 1984 and none in 1985 (CDFG 1991, Table 3.3.3-5). However, CDFG (1991) concludes that the monthly impaired flow pattern and quantity of water closely resembled the unimpaired flow with approximately 90 percent of the unimpaired flow released annually downstream of Camp Far West, indicating that flow was not the limiting factor influencing fall-run Chinook salmon ESU production.

Table 3.3.3-5. Estimates of spawning CV fall-run Chinook salmon ESU in the lower Bear River.[1]

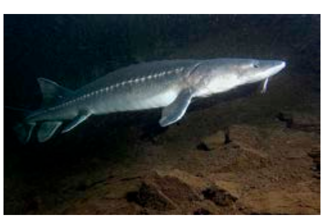
Year	Number of Chinook Salmon Adult Spawners	Instantaneous Flow Range (cfs)[2]		Highest Observed Instantaneous Flow in October & November (cfs)
		October	November	
1978	0	1.6 - 8.7	<1 - 14	14
1980	0	2.1 - 9.2	5 - 29	29
1982	<100	6.8 - 37	28 - 7,170	7,170
1983	>200[3]	37 - 55	484 - 4,360	4,360
1984	300	19 - 47	24 - 1,430	1,430
1985	0	4.4 - 33	10 - 28	28
1986	1	9.5 - 20	15 - 34	34

From: CDFG 1991
[1] CDFG Region 2, Rancho Cordova, file data for Bear River-Placer, Sutter, and Yuba counties, as cited in CDFG 1991.
[2] USGS Water Resources Data, California, Volume 4, various years, gage 11424000, Bear River near Wheatland, CA.
[3] Estimate of angler catch from Dry Creek.

The Central Valley Project Improvement Act (CVPIA) directed the Secretary of DOI to develop and implement a program that makes all reasonable efforts to double natural production of anadromous fish in California Central Valley streams (Section 3406(b)(1)). The program is known as the Anadromous Fish Restoration Program (AFRP). The 2001 plan was released by USFWS as a revised draft on May 30, 1997 and adopted as final on January 9, 2001 (USFWS 2001). The plan identifies restoration actions that may increase natural production of anadromous fish in Central Valley streams. The CVPIA target for natural production of Chinook salmon in the Bear River is 450 adults, though this target was established using a combination of the limited and low-quality abundance data presented in Table 3.3.3-5, above, and a "professional judgment" estimate of freshwater harvest. The CVPIA doubling goal and associated restoration and management actions identified to meet the goal are discussed in detail in Section 5.4.20 of this Exhibit E.

A more detailed discussion regarding CV fall-run Chinook salmon ESU in the lower Bear River is provided in Section 3.3.3.1.3.

White Sturgeon (CSC)[3]



White sturgeon is listed as a CSC due to a lack of abundance data, concerns regarding availability of spawning and rearing habitats, and the continued recreational importance of the species. Moyle (2002) states that the number of adults fluctuates annually and appears to be the result of highly variable juvenile production; the population is dominated by a few strong year classes associated with high spring

[3] Photo source - https://www.dfw.state.or.us/RR/images/fish/sturgeon/4803_white_sturgeon_swart_odfw.jpg

outflows. White sturgeon reside in estuaries of large rivers for much of their lives and tend to move around bays or estuaries to find optimal brackish water areas (Kohlhorst et al. 1991; USBR 2017a).

Data show that adult white sturgeon initiate their upstream migration into the lower Sacramento River from the Delta during late fall and winter (Kohlhorst and Cech 2001). The migration is believed to be triggered by photoperiod (Doroshov et al. 1997) and increases in river flow (Schaffter 1997). Mature adult white sturgeon have been documented moving up the Sacramento River until they are concentrated near Colusa from March through May (Kohlhorst et al. 1991 as cited in Kohlhorst and Cech 2001).

Onset of sexual maturity for males and females varies with photoperiod and temperature; however, male sturgeon reach maturity before females. Males are sexually mature as early as 3 to 4 years. Females mature as early as 5 years (Wang 2010). Only a small percentage of the adult population spawns in a given season. Males may spawn every 1 to 2 years, and females may spawn every 2 to 4 years. Limited data exists on preferential spawning habitat but biologists believe that white sturgeon pick deep swift water areas, such as riffles or pools with rock and gravel substrate, to spawn. Female sturgeon produce many eggs, with white sturgeon in the Sacramento River producing an average of 5,648 eggs per kilogram of body weight (Moyle 2002). Male sturgeon fertilize the eggs, giving them a tacky property that allows the eggs to stick to the substrate until the larvae emerge four to 12 days later (Wang 2010; USBR 2017a).

According to Moyle (2002), white sturgeon spawning typically occurs between February and June when water temperatures are 46° to 66°F. Biologists believe that adults broadcast spawn in the water column in areas with swift current. Fertilized eggs sink and attach to the gravel bottom, where they hatch. Eggs reportedly hatch after 4 days at 61°F (Beer 1981), but can take up to 2 weeks at lower water temperatures (PSMFC 1992). Exact white sturgeon spawning locations in the Sacramento River have not been documented, although it is likely white sturgeon spawn between Knights Landing (RM 90) and Colusa (RM 143) (CDFG 2002 and Schaffter 1997, both as cited in Beamesderfer et al. 2004; Kohlhorst 1976), or several miles upstream of Colusa (Kohlhorst 1976, and Schaffter 1997, all as cited in Israel et al. 2011). Vogel (2008) sampled adult sturgeons for a telemetry study on the Sacramento River near the Glenn-Colusa Irrigation District’s diversion between 2003 and 2006 and sampled white sturgeons as far upstream as RM 165.

After hatching, larvae begin swimming around in a vertical position as they are suspended by a yolk sac, making them more susceptible to be carried down to the estuary in the current (Wang 2010). Larvae begin to swim freely and feed through their mouths once the yolk sac has been consumed (Moyle 2002; USBR 2017a). Juvenile rearing and downstream movement can occur year-round.

Little information is available regarding white sturgeon use of the lower Bear River for spawning and rearing habitat. Recent studies conducted by DWR and utilizing Dual Frequency Identification Sonar (DIDSON) documented sturgeon presence in the lower 1 mi of the Bear River, but DWR was unable to determine species (A. Seesholtz, pers. comm., 2018). On March 28, 2017, DWR biologists reported detecting 24 adult sturgeon while conducting DIDSON surveys in the lower 1 mile of the Bear River. During that same time period, DWR staff reported they received anecdotal reports of anglers landing sturgeon in Wheatland just above the Highway 65 Bridge. On March 19, 2018, DWR repeated the DIDSON survey in the lower Bear River and reported detecting a total of 37 adult sturgeon within 1 mile of the Feather River confluence. During the survey, DWR staff reported watching an angler hook and land four white sturgeon approximately 0.5 mi upstream from the confluence with the Feather River. Additionally, DWR staff reported that a friend of a DWR biologist hooked and landed an adult white sturgeon on the Bear River on March 18, 2018.

CDFW deployed egg mats to investigate sturgeon spawning on the lower Bear River at eight sites in 2017 and at two sites in 2018 (CDFW 2018a and 2018b). Prior to deployment of the egg mats, CDFW conducted reconnaissance surveys with DIDSON cameras to identify potential spawning or holding locations on the Bear River. After identifying suitable locations, two egg mats were deployed at each sampling site. Sampling took place from March 7 through May 9, 2017, and March 27 through May 11, 2018. During the 2018 surveys, a logjam approximately 2.5 mi upstream from the confluence with the Feather River prevented access to six sites where mats were deployed in 2017. CDFW staff checked egg mats 3 to 4 times during the 2017 survey period, depending on accessibility due to flow conditions, and 4 times during the 2018 survey period. No sturgeon eggs were collected or observed on the egg mats and no sturgeon were observed during the DIDSON reconnaissance surveys in 2017 or 2018.

Hardhead (CSC)[4]

Hardhead has been reported to occur in the upper Yuba River, the lower Bear, Feather, and Yuba rivers and the Honcut Creek headwaters (UC Davis 2018). The report did not provide specific population counts for the lower Bear River.

Hardhead is a large cyprinid species that can reach lengths of over 23 in., and generally occurs in large, undisturbed, low- to mid-elevation, cool- to warm-water rivers and streams (Moyle 2002). Hardhead was designated CSC by CDFW in 1995, and is listed by CDFW as a Class 3 Watch List species, meaning that it occupies much of its native range but was formerly more widespread or abundant within that range (CDFG 2009a,b). Historically, hardhead was considered a widespread and locally abundant species in California, but its specialized habitat requirements, widespread alteration of downstream habitats, and predation by smallmouth bass (*Micropterus dolomieu*) have resulted in population declines and isolation of populations (Moyle 2002).

Most reservoir populations of hardhead have proved to be temporary; presumably the result of colonization of the reservoir by juvenile hardhead before introduced predators became established. Brown and Moyle (1993) observed that hardhead disappeared from the upper Kings River when the reach was invaded by bass.

Hardhead mature following their second year. Spawning migrations, which occur in the spring into smaller tributary streams, are common. The spawning season may extend into August in the foothill streams of the Sacramento and San Joaquin river basins. Spawning behavior has not

[4] Photo source - http://calfish.ucdavis.edu/calfish/Hardhead.html

been documented, but hardhead is believed to elicit mass spawning in gravel riffles (Moyle 2002). Little is known about life stage specific temperature requirements of hardhead; however, temperatures ranging from approximately 65° to 75°F are believed to be suitable (Moyle 2002).

In 1980, CDFG reported hardhead to be present in Camp Far West Reservoir. However, in 2012, CDFG conducted boat electrofishing surveys at nine sites in the reservoir and did not report any hardhead to be present. SSWD found no records of hardhead in the lower Bear River, and did not find any hardhead during its relicensing studies.

Sacramento Splittail (CSC)[5]

The Sacramento splittail, a minnow, was listed as threatened under the ESA on February 8, 1999, and delisted on September 22, 2003 (USFWS 2003a, b). Sacramento splittail is designated as a CSC (CDFW 2018c, CDFW2015b). Sacramento splittail is a large cyprinid, growing in excess of 12 in., and is adapted to living in freshwater and estuarine habitats as well as alkaline lakes and sloughs (Moyle 2002).

Historically, Sacramento splittail inhabited sloughs, lakes, and rivers of the Central Valley with populations extending upstream to Redding in the Sacramento River, to the vicinity of Colusa-Sacramento River State Recreation Area, in Butte Creek/Sutter Bypass, to Oroville in the Feather River, to Folsom in the American River, and to Friant in the San Joaquin River (Moyle et al. 2004, USFWS 2003b). Currently, the species is known to migrate up the Sacramento River to Red Bluff Diversion Dam and up the San Joaquin River to Salt Slough in wet years as well as into the lower reaches of the Feather and American rivers (USFWS 2003b).

Sacramento splittail has been documented only in the lower Feather River (UC Davis 2018) and, according to Moyle, evidence of self-sustaining populations of Sacramento splittail occurring outside of these areas is weak (Moyle et al. 2004). SSWD did not find any historic records of Sacramento splittail in the lower Bear River, and did not observe the species during its relicensing studies.

Sacramento-San Joaquin Roach (CSC)[6]

The Sacramento-San Joaquin roach, a CSC, is part of the California roach complex, which is composed of various subspecies. The Sacramento-San Joaquin roach is found in the Sacramento and San Joaquin River drainages, except the Pit River, and in other tributaries to San Francisco Bay. There is little quantitative information available on the abundance of Sacramento-San Joaquin roach. Assuming this widely distributed form is indeed just one subspecies, it appears to be abundant in a large number of streams. However, it is now absent from many streams and stream reaches where it once occurred (Leidy 1984).

Sacramento-San Joaquin roach is generally found in small, warm intermittent streams, and is

[5] Photo source http://swr.nmfs.noaa.gov/overview/sroffice/2Dredge_species_list.html
[6] Photo source - http://calfish.ucdavis.edu/calfish/CaliforniaRoach.htm

most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle 2002; Moyle et al. 1982). Assuming that the Sacramento-San Joaquin roach is indeed a single taxon, it is abundant in a large number of streams although it is now extirpated from a number of streams and stream reaches where it once occurred (Moyle 2002). Roach are tolerant of relatively high temperatures of 86° to 95°F and low oxygen levels of 1 to 2 mg/L (Taylor et al. 1982). However, it is a habitat generalist, also found in cold, well-aerated clear "trout" streams (Taylor et al. 1982), in human-modified habitats (Moyle 2002; Moyle et al. 1982) and in the main channels of rivers.

Reproduction occurs from March through early July, depending on water temperature (Moyle 2002). Murphy (1943) in CDFG 2008 states that spawning is determined by water temperature, which must be approximately 60°F for spawning to be initiated. During the spawning season, schools of fish move into shallow areas with moderate flow and gravel/rubble substrate (Moyle 2002). Females deposit adhesive eggs in the substrate interstices and the eggs are fertilized by attendant males. Typically, 250-900 eggs are produced by a female and the eggs hatch within two to three days. Fry remain in the substrate interstices until they are free-swimming.

Sacramento-San Joaquin roach have been reported to occur in the upper Yuba River, the lower Bear and Feather rivers, the Middle Fork of the Feather River, and the Honcut Creek headwaters (UC Davis 2018). SSWD did not find any Sacramento-San Joaquin roach during its relicensing studies in the lower Bear River.

Foothill Yellow-Legged Frog (CSC, CESA Candidate Species)[7]

The foothill yellow-legged frog (FYLF) is currently a candidate for listing as threatened under the CESA. On June 21, 2017, the California Fish and Game Commission accepted for consideration a petition from the Center for Biological Diversity to list FYLF as a threatened species, with a finding by CDFW (2017a) that the petitioned action may be warranted. Based on this finding and acceptance of the petition, the Fish and Game Commission advanced the FYLF to a candidate species under the CESA. As a candidate species, FYLF receives all the protections of a CESA-listed species for 1 year from the date it was accepted for consideration while the Fish and Game Commission and CDFW staff decide whether to provide permanent protection to FYLF as a listed species under CESA. This 1 year period has elapsed with no action by the California Fish and Game Commission, so FYLF's status as a CESA Candidate species is uncertain. Nevertheless, FYLF remains a CSC, so it is treated as an aquatic special status species in this Exhibit E.

FYLF is a stream-adapted species, usually associated with shallow, flowing streams with backwater habitats and coarse cobble-sized substrates (Jennings and Hayes 1994). Known extant populations, particularly in the Sierra Nevada, are concentrated between about 600 to 5,000 ft elevation, although populations since extirpated once occurred at elevations below 300 ft in some areas (Moyle 1973; Seltenrich and Pool 2002; ECORP 2005). The species has declined range wide, most severely in southern California, where it evidently no longer occurs (CDFW 2017c).

[7] Photo source: Stephen Nyman, PhD

Within the Central/Northern Sierra Nevada region, populations persist on some portions of previously occupied drainages (NatureServe© 2018), but many of these populations are smaller and more fragmented than historically (CDFW 2017c). FYLF populations may require both mainstem and tributary habitats for long-term persistence. Streams too small to provide breeding habitat for this species may be critical as seasonal habitats (e.g., in winter and during the hottest part of the summer) (VanWagner 1996; Seltenrich and Pool 2002), and there is evidence that habitat use by young-of-the-year, sub-adult, and adult frogs differs by age-class and changes seasonally (Randall 1997). Adult migrations appear to be limited to modest movements along stream corridors (Ashton et al. 1998), but the magnitude of such movements, any seasonal component, and differences between sexes remains largely unknown. FYLF is infrequent in habitats where introduced fish and bullfrogs are present (Jennings and Hayes 1994).

Breeding tends to occur in spring or early summer and eggs are laid in areas of shallow, slow-moving waters near the shore. Timing and duration of breeding activity may vary geographically and across populations. In California, egg masses have been found between April 22 and July 6, with an average of May 3 (Ashton et al. 1998). Kupferberg (1996a, b) reports an approximate breeding period of 1 month beginning late April to late May. Rainfall during a given breeding season has the potential to delay oviposition (Kupferberg 1996a, b).

Egg masses vary in size and in the number of eggs/mass. The size of an egg mass after it has absorbed water (usually a few hours after oviposition) is 5 to 10 cm in diameter and "*resembles a cluster of grapes*" (Stebbins 1985). The number of eggs in a mass can range from 300 to 2,000 (Zweifel 1955), with an average of about 900 eggs (Ashton et al., 1998). Eggs generally hatch within 5 to 37 days (Zweifel 1955; Ashton et al. 1998). Hatching rates are influenced by temperature, with faster developmental times in warmer waters, up to the critical thermal maximum temperature of about 26˚C (Zweifel 1955; Duellman and Trueb 1986). Tadpoles move away from their egg mass after hatching (Ashton et al. 1998) and typically metamorphose 3 to 4 months after hatching.

FYLF is known to occur at higher elevations within the Bear River watershed, but occurrences at the low elevations of the Project (i.e., below 320 ft) are unlikely because the Project is below the accepted elevation range of 600 ft for the species. A search of the CNDDB for the USGS 1:24,000 quadrangles of Camp Far West, Nicolaus, Sheridan, Wheatland, and Wolf found no known occurrences of FYLF (CDFW 2018c). Through a search of the literature, no other studies or known occurrences of FYLF in the Project Area were found, and SSWD did not observe FYLF during its relicensing studies in the lower Bear River.

Western Pond Turtle (CSC)[8]

The western, or northwestern, pond turtle (WPT) occurs in a wide variety of aquatic habitats up to a 6,000 ft elevation, particularly permanent ponds, lakes, side channels, backwaters, and pools of streams, but is uncommon in high-gradient streams (Jennings and Hayes 1994). Western pond turtle has declined due to loss of habitat, introduced species, and historical over-collection (Jennings

[8] Photo source: http://sfbaywildlife.info/species/pacific_pond_turtle.htm

and Hayes 1994), and has been designated as CSC. Isolated occurrences of WPT in lakes and reservoirs sometimes occur from deliberate releases of pets.

Although highly aquatic, WPT often overwinters in forested habitats and eggs are laid in shallow nests in sandy or loamy soil in summer at upland sites as much as 1,200 ft from aquatic habitats (Jennings and Hayes 1994). Hatchlings do not typically emerge from the covered nests until the following spring. Reese and Welsh (1997) documented WPT away from aquatic habitats for as much as 7 months in a year and suggested that terrestrial habitat use was at least in part a response to seasonal high flows. Basking sites are an important habitat element (Jennings and Hayes 1994) and basking occurs on substrates include rocks, logs, banks, emergent vegetation, root masses, and tree limbs (Reese undated). Terrestrial activities include basking, overwintering, nesting, and moving between ephemeral sources of water (Holland 1991). During the terrestrial period, Reese and Welsh (1997) found that radio-tracked WPT were burrowed in leaf litter.

Breeding activity may occur year-round in California, but egg-laying tends to peak in June and July in colder climates, when females begin to search for suitable nesting sites upslope from water. Adult WPTs have been documented traveling long distances from perennial watercourses for both aestivation and nesting, with long-range movements to aestivation sites averaging about 820 ft, and nesting movements averaging about 295 ft (Rathbun et al. 2002). Introduced species of turtles (e.g., red-eared sliders [*Trachemys scripta elegans*]) are likely to compete with western pond turtle for basking sites, while bullfrogs and predatory fish species may prey on hatchling western pond turtles. Major factors cited as limiting WPT populations include loss of aquatic habitats, elevated nest and hatchling predation, reduced availability of nest habitat, and road mortality (BLM and USFWS 2009).

CDFW (2018a) reports six occurrences of WPT in the Project Vicinity, none of which are in Camp Far West Reservoir or the mainstem of the lower Bear River. The occurrences were: 1) in Dry Creek about 2.5 mi west of Wheatland, approximately 8.5 mi from Camp Far West Dam; 2) the south end of Wood Duck Slough, 2 mi north of Nicolaus, approximately 16.7 mi from Camp Far West Dam; 3) the upper end of Best Slough, South of Beale Air Force Base, approximately 4.3 mi from Camp Far West Dam; 4) along Dry Creek, approximately 1-mi east of the junction of Spenceville Road and Waldo Road in the Spenceville Wildlife Area, approximately 4.3 mi from Camp Far West Dam; 5) along Dry Creek, approximately 1.3 mi east of the junction of Spenceville Road and Waldo Road in the Spenceville Wildlife Area, approximately 4.4 mi from Camp Far West Dam; and 6) along the north bank of Dry Creek about 0.25 west/southwest of Shingle Falls and 1.6 miles northeast of Spenceville Rd at Nichols Rd within the Spenceville Wildlife Area, approximately 4.2 miles from Camp Far West Dam. No incidental observations of western pond turtle were recorded during relicensing studies. Through a search of the literature, no other studies or known occurrences of WPT were found in Camp Far West Reservoir or the lower Bear River.

3.3.3.1.2 Aquatic Invasive Species

The USFWS Fisheries Program defines aquatic invasive species (AIS) as "aquatic organisms that invade ecosystems beyond their natural, historic range and may harm native ecosystems or commercial, agricultural, or recreational activities."[9] Although most AIS are nonindigenous (i.e., exotic or non-native in origin), also included in this category are native species that grow out of control in their natural habitats due to excessive nutrients, warmer waters, or other factors. The USGS maintains a list of AIS, including reported geographical locations (USGS 2018a). Based on a search of the USGS Non-indigenous Aquatic Animals database (USGS 2018a) and the CalWeedMapper database (Cal-IPC 2018a) and other information, two AIS occur in Camp Far West Reservoir and one in the sewage ponds in the recreation areas. These are: 1) Asian clam (*Corbicula fluminea*); 2) floating water primrose (*Ludwigia peploides* ssp. *montevidensis*); and 3) American bullfrog (*Lithobates catesbeianus*). Eight other AIS are known to occur with 100 mi of Camp Far West Reservoir. These are: 1) New Zealand mudsnail (*Potamopyrgus antipodarum*): 2) Carolina fanwort (*Cabomba caroliniana*); 3) Brazilian waterweed (*Egeria densa*); 4) water hyacinth (*Eichhornia crassipes*); 5) hydrilla (*Hydrilla verticillata*); 6) parrot's feather milfoil (*Myriophyllum aquaticum*); 7) Eurasian watermilfoil (*Myriophyllum spicatum*) and 8) curly leaf pondweed (*Potamogeton crispus*). Table 3.3.3-6 lists these two mollusks (snails and bivalves), eight aquatic plants and one amphibian, and provides information, including listing status, on each.

Table 3.3.3-6. Aquatic invasive species known or with the potential to occur in the Project Vicinity.

Common Name/ Scientific Name	Status	Habitat Requirements	Located Within Project Vicinity
AIS KNOWN TO OCCUR IN CAMP FAR WEST RESERVOIR			
Asian clam *Corbicula fluminea*	None[1]	Freshwater lakes, reservoirs and streams, and often bury themselves in sandy, bottom sediments	Yes. In 2014, Asian clams were reported in Camp Far West Reservoir at NSRA and SSRA boat launches (USGS 2018c)
Floating water primrose *Ludwigia peploides ssp. montevidensis*	Cal-IPC 'high' species	Shallow, stagnant, nutrient-rich water such as flood control channels, irrigation ditches, and holding ponds	Yes. The species was located during SSWD's relicensing Botanical Resources Study at the NSRA and SSRA in Camp Far West Reservoir.
American bullfrog *Lithobates catesbeianus*	None[1]	Quiet waters of ponds, lakes, reservoirs, irrigation ditches, streams, and marshes	Yes. The species was located at multiple locations adjacent to Camp Far West Reservoir, but not within the Reservoir, during SSWD's relicensing studies, including at both recreation area sewage ponds. Also observed during surveys for the 2013 Biological Assessment (specific locations not indicated) (ESA 2013).
Subtotal	*4*		
AIS THAT DO NOT OCCUR WITHIN CAMP FAR WEST RESERVOIR, BUT ARE KNONW TO OCCUR WITHIN 100 MILES OF THE RESERVOIR			
New Zealand mudsnail *Potamopyrgus antipodarum*	C.C.R. 14 Section 671(c)(10), Restricted Species	Freshwater and brackish lakes, reservoirs and streams	No. Closest known occurrence is on the Yuba River below the Highway 20 bridge, approximately 10 mi from the Project (USGS 2018h).
Carolina fanwort *Cabomba caroliniana*	CDFA Q-rated	Mud of stagnant to slow-flowing water, including streams and smaller rivers	No. The closest occurrence to the Project is in Snodgrass Slough in Sacramento County, approximately 70 mi away (Cal-IPC 2018b).
Brazilian waterweed *Egeria densa*	Cal-IPC 'high' species	Slowly moving non-turbid shallow waters of lakes, springs, ponds, streams, and sloughs	No, this species was reported in the Camp Far West quad, but without specific location Cal-IPC 2018b).

[9] Available online: https://www.fws.gov/fisheries/ans/index.html

Table 3.3.3-6. (continued)

Common Name/ Scientific Name	Status	Habitat Requirements	Located Within Project Vicinity
AIS THAT DO NOT OCCUR WITHIN CAMP FAR WEST RESERVOIR, BUT ARE KNONW TO OCCUR WITHIN 100 MILES OF THE RESERVOIR (cont'd)			
Water hyacinth *Eichhornia crassipes*	Cal-IPC 'high' species CDFA C-rated	Both natural and man-made freshwater systems (e.g., ponds, sloughs and rivers)	No. The nearest occurrences of water hyacinth is just north of Mount Vernon Road in the neighboring Lincoln quadrangle, about 15 mi southeast of Camp Far West Reservoir (Cal-IPC 2018b).
Hydrilla *Hydrilla verticillata*	C.C.R. 3 Section 3962(a)(1) Cal-IPC 'high' species CDFA A-rated	Freshwater lakes, ponds, and slow-moving waters	No, the closest occurrence of hydrilla to the Project is in Placer County (Wolf quadrangle), south of Fenton Ravine, approximately 1 mi south and downstream of Camp Far West Reservoir (Cal-IPC 2018b).
Parrot's feather milfoil *Myriophyllum aquaticum*	Cal-IPC 'high' species	Ponds, lakes, rivers, streams, canals, and ditches, usually in still or slow-moving water, but occasionally in faster-moving water of streams and rivers	No. The species has been reported to be located 3.5 mi northwest of Camp Far West Reservoir, within the Beale Air Force Base (USGS 2018k).
Eurasian watermilfoil *Myriophyllum spicatum*	Cal-IPC 'high' species CDFA C-rated	Surface of freshwater lakes, ponds, and slow-moving waters	Yes. The species has been reported to be located 0.5 mi northwest of Camp Far West Reservoir just outside the NSRA (Cal-IPC 2018b).
Curly leaf pondweed *Potamogeton crispus*	Cal-IPC 'moderate' species	Quiet waters, especially brackish, alkaline, or eutrophic waters of ponds, lakes, and streams	No. Curly leaf pondweed has been located about 12 mi south of the Project in Placer County (in neighboring Wolf quadrangle), but has not been documented from Camp Far West Reservoir (Cal-IPC 2018b).
Subtotal	*7*		
Total	**11**		

Key:
[1] Although not formally listed, these species are invasive and of interest to natural resource agencies, including the CDFW and USFWS, for their impacts on native species.
Cal-IPC Inventory (Cal_IPC 2018a):
High: Species with severe ecological impacts; high rates of dispersal; ecologically widely-distributed
Moderate: Species with substantial and apparent ecological impacts; moderate to high rates of dispersal; ecologically limited to widespread
California Department of Food and Agriculture
A: Those organisms of known economic importance subject to state enforced action (i.e., eradication, quarantine regulation, containment, rejection or other holding action)
Q: Those organisms requiring temporary "A" action
C: Those organisms subject to no state-enforced action outside of nurseries except to retard spread OR no state-enforced action except to provide for pest cleanliness in nurseries.
Sources: Cal-IPC 2018a; CDFA 2018; USGS 2018a

Two other AIS - zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena rostriformis bugensis*) - do not occur within 200 mi of the Project, but are included here because of the serious concern for these species in California.

Each of the AIS listed in Table 3.3.3-6 and zebra and quagga mussels is described below.

AIS Known to Occur in Camp Far West Reservoir

Asian Clam

Asian clam is a small (around 0.2-in.), freshwater mollusk, native to temperate and tropical southern Asia, eastern Mediterranean and the Southeast Asian islands to Australia. This species was first located in the U.S. in 1938 in the Columbia River and is believed to have been brought by Chinese immigrants as food. People have spread the species through bait buckets, aquaculture and intentional introductions for consumption (USGS 2018b).

In California, Asian clams are also known in the Sacramento and San Joaquin drainages, Santa Barbara County south to San Diego County, the Salton Sea and the San Francisco Bay (USGS 2018b).

Asian clams can inhabit freshwater lakes, reservoirs and streams, and often bury themselves in sandy, bottom sediments. These clams can foul complex power and water systems and have temporarily closed down nuclear power plants and weakened concrete structures in the U.S. An inhibiting factor for the species is temperature, as they have a low tolerance to cold temperatures, which can cause their populations to fluctuate (USGS 2018c). Nonetheless, Asian clams are well-established in Lake Tahoe, an area with winter time freezing temperatures, at depths from 5 ft to 250 ft, though the individuals are smaller than those in warmer waters (TERC 2015). The species is also sensitive to salinity, drying, low pH and siltation (USGS 2018b).

Management methods for Asian clam include mechanical (e.g., scraping colonies off substrate), bottom barriers, suction removal and chemical and temperature alteration, though some of these techniques cannot be used in many water bodies (USGS 2018b).

In 2014, an unspecified number of Asian clam specimens were collected in Camp Far West Reservoir at the NSRA and SSRA boat launches (USGS 2018c).

<u>Floating Water Primrose</u>

Several native and non-native water primrose species are found in California. Native species include floating water primrose (*Ludwigia peploides peploides*). Non-native species include Uruguay water-primrose (*L. hexapetala*) and creeping water primrose (*L. peploides* ssp. *montevidensis*), among others. Water primrose is part of the aquatic plant Subfamily Ludwigioideae (Family Onagraceae), of which most species are native to South America. Water primroses are floating to emergent perennials with stems up to 10 ft long. Flowers have five petals and are bright yellow (DiTomaso et al. 2013). Stems from dense mats in waterways, reaching above and below the water surface (Cal-IPC 2018b).

Water primrose is found throughout the central and northern Central Valley, especially in Sacramento, Yuba, and Sutter counties and the Sacramento-San Joaquin Delta.

Water primrose reproduces vegetatively (roots, rhizomes, and plant fragments) and by seed, although seedlings are rarely encountered (DiTomaso et al. 2013). Water primrose establishes in areas with disturbed hydrology, high nutrient loading and flooding. The species favors areas of shallow, stagnant, nutrient-rich water such as flood control channels, irrigation ditches, and holding ponds. It is a freshwater aquatic vascular plant that is able to persist in both wet and dry transitional zones, such as lakes, ponds, reservoirs, rivers, stream, canals, bogs, marshes, riparian and bottomland habitats (Cal-IPC 2018b).

Water primrose's main mode of dispersal is by flowing water when floating mats or shoots break off, however water primrose fragments can catch onto boats and other watercraft which spreads plants to new areas. The species has also been documented to be consumed and possibly transported by ducks and other waterfowl. It is a common ornamental plant and believed to be widely-spread by humans. Since it thrives in nutrient-rich waters, its spread may be facilitated by nursery cultivation/commercial use and animals (Cal-IPC 2018b).

Water primrose is rated as a "high" level invasive by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2018b).

Incidental sightings of floating water primrose were found in ponds within the Camp Far West Reservoir off of the NSRA and SSRA during SSWD's Botanical Resources Study.

<u>American Bullfrog</u>

The American bullfrog is a large frog with an average snout to vent length ranging between 3.5 and 8 in. Its color varies, with most individuals being light green to dark olive green, with dark spots and blotches. Adult American bullfrogs are opportunistic feeders taking insects, worms, crustaceans, birds, bats, rodents, lizards, snakes, turtles, newts, and other frogs and tadpoles (Nafis 2018; CDFW 2017a).

American bullfrogs occur near permanent or semi-permanent water throughout California, including the quiet waters of ponds, lakes, reservoirs, irrigation ditches, streams, and marshes.

In California, breeding and egg-laying occur from March to July (CDFW 2017a). Reproduction begins when the air temperature reaches a certain level (measured at one location in Kansas at 70°F [Nafis 2018]). Females deposit 10,000 to 20,000 eggs in disk-shaped masses about 1 egg thick and 1 ft to 5 ft in diameter. Eggs are deposited among aquatic plants or brush growing on the bottom. In some localities, they may produce more than one clutch per season. Tadpoles use shallow waters near shore while completing development, which can take up to 6 months. Individuals in many populations overwinter as tadpoles and transform during their second year (CDFW 2017a).

As demonstrated by their diet and high tadpole survival rates, bullfrogs are adaptable. In addition, they are not as sensitive to temperature and pollution as California's native frogs. Bullfrogs are found at elevation ranges from sea level to 6000 ft (Zeiner et al. 1988). In desert regions, they occur along the Mojave and Colorado rivers and in areas where irrigation creates suitable habitat. Bullfrogs can travel great distances, especially during wet periods (CDFW 2017a).

Native to central and eastern North America, American bullfrogs were introduced to California and the West for their meat (legs), as biological controls for insects, and accidentally during fish stocking. Most fish appear to be averse to eating American bullfrog tadpoles because of their undesirable taste and, other than people, the adult American bullfrog has few predators. Nevertheless, American bullfrog tadpoles, and some adults, are preyed upon by aquatic insects, fish, garter snakes, wading birds, and probably a few nocturnal mammals (CDFW 2017a).

As a result of their feeding behaviors and adaptability to natural and manmade aquatic environments, larval and post-metamorphic lifestages of American bullfrogs prey upon and are able to out-compete native frogs and other aquatic species. Additionally, American bullfrogs are a known carrier of chytrid fungus, which causes the potentially fatal skin disease in frogs called chytridiomycosis. Chytridomycosis is believed to be a leading cause of the decline of native amphibian populations all over the world and responsible for the extinction of over 100 species since the 1970s (CDFW 2017a).

Management methods for American bullfrogs are limited to localized populations, as eradicating bullfrogs from large waterbodies is currently infeasible. Currently, there are only a few methods for managing bullfrogs, including chemical control, bullfrog-specific traps and hunting. Prevention remains the best means of management (Snow and Witmer 2010).

American bullfrogs were located at multiple locations north and south of Camp Far West Reservoir during SSWD's relicensing studies at Camp Far West Reservoir in 2016 and 2017, including in sewage ponds at both recreation areas.

AIS Within 100 Miles of Camp Far West Reservoir

<u>New Zealand Mudsnail</u>
New Zealand mudsnail is a small (around 0.16 to 0.24 in.), freshwater mollusk, native to the lakes and streams in New Zealand and nearby small islands. Ballast water discharge from commercial cargo ships into the Great Lakes is most likely responsible for their introduction into the U.S. Since then, recreationists and recreational and commercial boating have facilitated their spread westward (USGS 2018g).

New Zealand mudsnails can inhabit freshwater and brackish lakes, reservoirs and streams. They can tolerate siltation and benefit from disturbance and high nutrient flows. These snails can compete with other grazers and cause decreases in species richness. Reduction in algal production can rapidly reduce food resources for native species. An inhibiting factor for the species is temperature, as it cannot tolerate temperatures below freezing or above 93°F (USGS 2018g).

There are a couple of potential management strategies for New Zealand mudsnails, mostly for small waterbodies that can be isolated from the rest of a system. Methods include chemical control and draining water to allow substrate to heat and freeze. CDFW has suggested methods for decontaminating equipment and boats after using them in known infested waters (CDFW 2015a).

Under C.C.R. 14 § 671(c)(9)(A), New Zealand mudsnails are listed as a Restricted Species, which means it is "*unlawful to import, transport, or possess live (New Zealand mudsnail)…except under permit issued by the department.*" Additionally, pursuant to this regulation, New Zealand mudsnails are termed "detrimental," which means they pose a threat to native wildlife, the agricultural interests of the state, or to public health or safety.

The closest known location of New Zealand mudsnails to the Project is on the Yuba River downstream of the Highway 20 Bridge. The species is fairly widespread in California (USGS 2018h).

Carolina Fanwort

Carolina fanwort or fanwort is a submersed, sometimes floating, but often rooted, freshwater perennial plant. Its shoots are grass green to olive green or sometimes reddish brown. The leaves are of two types: submersed and floating. The submersed leaves are finely divided and arranged in pairs on the stem. The floating leaves, when present, are linear and inconspicuous, with an alternate arrangement. They are less than 0.5-in. long and narrow (i.e., less than 0.25-in.) (DiTomaso 2010). Flowers are on stalks rising from the tips of stems and are white to pink to purplish and about 0.5-in. across (DiTomaso et al. 2013)

Fanwort grows rooted in the mud of stagnant-to slow flowing water, including streams and smaller rivers. The plants flower from May to September. Although seeds are produced, there is little known about seed viability or soil longevity. Like most aquatic plants, fanwort reproduces vegetatively from small fragments. In the late summer, fanwort stems become brittle, which causes the plant to break apart, facilitating its distribution and invasion of new water bodies (DiTomaso 2010).

In California, there have been sightings of fanwort in Contra Costa, Sacramento, and San Joaquin counties, and it is present in the Sacramento-San Joaquin Delta. The species is native to the eastern U.S., but has spread beyond its range both in North America and on other continents (DiTomaso 2010).

Mechanical control can contribute to the spread of fanwort since it easily fragments, however a venture dredge, which acts like a giant vacuum cleaner, can minimize fragmentation and extract the rootball. Draining a waterbody can provide temporary control of fanwort; growth can be suppressed if areas are dewatered in high temperatures and allowed to dry or dewatered during hard freezes. Potential biological control agents have been identified and are currently being investigated in the laboratory in Argentina, but no successful field releases have been made. Some of the same herbicides used to control Brazilian waterweed and water hyacinth can be used to control fanwort (DiTomaso et al. 2013).

The closest occurrence to the Project is in Snodgrass Slough in Sacramento County, approximately 70 mi away (USGS 2018i).

Brazilian Waterweed

Brazilian waterweed[10] is a fast-growing, shallow-water perennial aquatic plant that grows rooted in mud, submerged or floating, with stems up to 15 ft long and 1/8-in. thick. Its leaves are small, smooth, spear-shaped, 1 to 2.5 in. long, 0.06 to 0.12-in. wide, arranged in whorls of three to six leaves, with many whorls along stem. It displays prominent white flowers extending 1.5 in. above the water surface on long, thread-like flower tubes attached to stems (SFEI 2014; DiTomaso et al. 2013).

All populations of Brazilian waterweed in the western U.S. reproduce vegetatively by stolon and stem fragments as all plants are male and no fruit is produced. Although similar in appearance to hydrilla, Brazilian waterweed does not produce tubers or turions. Plants easily break into free-floating fragments and disperse to new areas by water flow, waterfowl, and human activities

[10] Also known as "*Egeria elodea*" or "Brazilian elodea."

such as fishing and boating. However, only fragments with a double node can develop into new plants (DiTomaso et al. 2013).

Native to South America, Brazilian waterweed was introduced to California more than 30 years ago and now infests approximately 12,000 ac of the 61,619 surface ac of the Sacramento-San Joaquin Delta. Commonly sold as aquarium decor, it may have been introduced to the Delta when dumped by an aquarium owner (DBOW 2012). Brazilian waterweed is found throughout the California Central Valley, especially between Stockton and Butte counties, and in the Sacramento-San Joaquin Delta and tributaries.

Brazilian waterweed prefers slowly moving non-turbid shallow waters of lakes, springs, ponds, streams, and sloughs, rarely establishing itself greater than 20 ft below the surface. Brazilian waterweed's growth is affected by nutrient status, light intensity, day length, temperature, turbidity, salinity, and rate of water flow. The plant inhabits acidic to alkaline waters and is highly susceptible to iron deficiencies and salinity. In the Delta, plants grow year-round with maximum growth occurring in the spring. Ideal temperatures range between 50°F and 80°F, but in climates with colder temperatures, Brazilian waterweed senesces in winter (SFEI 2014).

Mechanical control and herbicides are effective methods of control. However, Brazilian waterweed can propagate from small sections of stem, so repeated treatments are often necessary for full control (Cal-IPC 2018b). Triploid grass carp may be a good option for control, as Brazilian waterweed is one of its most preferred diets, although a permit is required from CDFW for possession and use of this species. DBOW conducts annual treatments for Brazilian waterweed and is the only agency in California authorized to use herbicides in the Delta and its tributaries. In 2016, DBOW conducted herbicide treatments from March through November, including in the Sacramento area, on 1,529 surface water acres (DBOW 2017).

Brazilian waterweed is given a "high" invasive plant rating by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2018a).

The nearest known Brazilian waterweed occurrence to the Project is a record within the Camp Far West quadrangle (i.e., not in or adjacent to the reservoir) in 2011 (Cal-IPC 2018a). The population within the quadrangle was noted as high in abundance, but not spreading due to a saturated ecological niche according to CalWeedMapper (Cal-IPC 2018a). Brazilian waterweed is currently not under management in this quadrangle (Cal-IPC 2018a).

<u>Water Hyacinth</u>

Water hyacinth is a free-floating perennial. It has bushy, fibrous roots and is often found in large mats on the water surface measuring tens or hundreds of feet in diameter. Seedlings are most often rooted in mud along shorelines or on floating mats. Leaves are round or oval and shiny green and 3 to 8 in. across. Buoyant bulbs are present at the base of the leaf stalks an attached to a thick erect stem which can grow up to 2 ft tall (DiTomaso et al. 2013; Cal-IPC 2018b). Water hyacinth flowers are pale blue, purple to whitish with six petals (Cal-IPC 2018b).

Water hyacinth can be found in both natural and man-made freshwater systems (e.g., ponds, sloughs and rivers). It cannot tolerate brackish or saline water with salinity levels above 1.8

percent. Water hyacinth obtains nutrients directly from the water and can double its size every ten days in hot weather. Water hyacinth's transpiration rate is calculated to be almost eight times the evaporation rate of open water. It alters water quality beneath the mats by lowering pH, dissolved oxygen and light levels, and increasing carbon dioxide and turbidity (Cal-IPC 2018b).

Vegetative reproduction occurs from late spring through fall. Water hyacinth reproduces primarily from pieces of runners, and in as little as a week, the number of individuals can double. Plant fragments can spread via a number of mechanisms, "daughter" plants break off and float downstream, or the stout leaves act like sails and float downstream en masse. Water hyacinth also reproduces by seed which can spread by water flow and clinging to the feet or feathers of birds. Seeds require warm, shallow water and high light intensity for germination. Seeds can remain viable in sediment for 15 to 20 years (Cal-IPC 2018b; DiTomaso et al. 2013).

Native to Central and South America, water hyacinth was introduced into the U.S. in 1884 as an ornamental plant for water gardens. By 1904, water hyacinth had made its way into Yolo County, California. In California, water hyacinth typically is found below 660 ft elevation in the Central Valley, San Francisco Bay Area, and South Coast (Cal-IPC 2018b). The Sacramento-San Joaquin Delta and several of the rivers draining into the Delta are heavily infested.

At present, aquatic herbicides remain the primary tools available to control water hyacinth. Two weevils and a moth have been introduced as biological controls, but have not demonstrated much success. Most animals, except rabbits, do not readily eat the plant, possibly because its leaves are 95 percent water and have a high tannin content (Cal-IPC 2018b). The DBOW conducts annual treatments for water hyacinth and is the only agency in California currently authorized to use herbicides in the Delta and tributaries. In 2014, DBOW treated 4,445 surface acres of water hyacinth with herbicides and an additional 4,100 surface acres mechanically (DBOW 2017).

Cal-IPC gives water hyacinth a "high" invasive plant rating, meaning 'the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure' (Cal-IPC 2018b).

The nearest occurrences of water hyacinth to the Project Area is north of Mount Vernon Road, in the neighboring Lincoln quadrangle, about 15 miles southeast of Camp Far West Reservoir (Cal-IPC 2018a).

Hydrilla

The submerged aquatic perennial hydrilla has small spear-shaped leaves up to 1-in. long and 1 to 4 mm-wide, with toothed edges, arranged in whorls of usually 5 to 8 leaves, with many whorls along each stem. Typically, it is found in shallow (i.e., less than 11.5 ft) water, but if the water is clear enough it may be found growing to depths of 48 ft (DiTomaso et al. 2013; Cal-IPC 2018b).

Hydrilla grows rapidly in spring and summer, creating dense mats in freshwater lakes, ponds, and slow-moving waters. In spring, when water temperatures exceed 60°F, hydrilla begins to grow, producing large amounts of biomass by late summer and early fall. It can tolerate some salinity and is sometimes found in upper estuaries. It grows better on mud than on sand. Growth is enhanced in water with agricultural runoff that raises nutrient levels. Dieback of above-ground portions of the plant usually occurs in late fall and winter (Cal-IPC 2018b).

Hydrilla can reproduce by fragmentation of stems, rhizomes, root crowns, and by the production of tubers and turions. The plant is most likely to spread when fragments are carried into new waterbodies by recreational watercraft or water dispersal. Once established, it produces a bank of tubers and turions in the soil that may remain viable for three to five years (Cal-IPC 2018b).

Hydrilla was imported into the U.S. from Asia in the late 1950s for aquarium use. In California, hydrilla was first found in Yuba County in 1976 (Cal-IPC 2018b) and has since been found in 17 of California's 58 counties. The California Department of Food and Agriculture (CDFA) implements and eradication program specifically for hydrilla. The CDFA has successfully eradicated hydrilla from fourteen counties and currently conducts hydrilla eradication efforts in four counties throughout California integrating various methods of control, though the last posted report is from 2013 (CDFA 2018). The closest occurrence of hydrilla to the Project is in Placer County about 4 miles away in a pond (USGS 2018j).

Manual removal of hydrilla can be used for small infestations, but herbicides are usually necessary for large infestations. Sterile triploid grass carp (*Ctenopharyngodon idella*) are approved for hydrilla control in the Imperial Irrigation District drainage system in southeastern California by permit issued by CDFW (Cal-IPC 2018b, SFEI 2014).

Hydrilla is listed by the CDFA as an A-rated noxious weed, which means "*a pest of known economic or environmental detriment and is either not known to be established in California or it is present in a limited distribution that allows for the possibility of eradication or successful containment* (and is) *subject to state enforced action involving eradication, quarantine regulation, containment, rejection, or other holding action*" (CDFA 2015). CDFA implements an ongoing program to eradicate hydrilla from California. Yuba and Nevada counties are designated hydrilla eradication areas pursuant to C.C.R. 3 § 3962(a)(1). Cal-IPC gives hydrilla an invasive plant rating of "high," meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2018b).

The closest occurrence of hydrilla to the Project is in Placer County (Wolf quadrangle), south of Fenton Ravine, approximately 1 mile south and downstream of Camp Far West Reservoir (Cal-IPC 2018a).

<u>Parrot's Feather Milfoil</u>

Parrot's feather milfoil is a stout aquatic perennial that forms dense mats of intertwined brownish rhizomes in water (CDFA 2016). Stems are mostly submerged and can grow up to 16 ft in length. Submersed leaves are arranged in whorls of three to six per node; emergent leaves are similar in appearance but are slightly thicker. Additionally, emerged leaves are light gray-green and resemble a bottlebrush. The bottlebrush appearance results from the fact that the leaves appear in whorls of four to six at each node and each leaf is feather-like, the blade divided into twenty-four to thirty-six thread-like segments. Unlike other milfoils (*Myriophyllum* spp.), parrot's feather stems may grow as much as 8 in. above the water surface (DiTomaso et al. 2013).

Parrot's feather milfoil occurs in ponds, lakes, rivers, streams, canals, and ditches, usually in still or slow-moving water, but occasionally in faster-moving water of streams and rivers. It tolerates soft to very hard water and a pH range of 5.5 to 9.0. It does not tolerate brackish water and requires high light conditions (USGS 2018k). In north and central California, it is wide spread through the Central Valley and North Coast, especially in Mendocino, Butte, Yuba, and Sutter counties, with occurrences also in Nevada and Placer counties.

Introduced from South America as an aquarium plant and pond ornamental in the late 1800s to early 1900s, parrot's feather milfoil grows best in tropical regions and can survive freezing by becoming dormant. In California, parrot's feather milfoil grows most rapidly from March until September. In spring, shoots begin to grow rapidly from overwintering rhizomes as water temperature increases. Underwater leaves tend to senesce as the season advances. Plants usually flower in the spring, but may also flower in the fall (CDFA 2016).

With its tough rhizomes, parrot's feather milfoil can be transported long distances on boat trailers. Any rhizome or stem sections with at least one node, even as small as 0.2-in. long, can root and establish new plants. Rhizomes stored under moist conditions in a refrigerator survived for one year. Once rooted, these new plants produce rhizomes that spread through sediments and stems that grow until they reach the water surface (CDFA 2016). Most plants in its introduced range are female, thus only populations within its native range develop seed (DiTomaso et al. 2013).

Biological, mechanical, and chemical controls have all been attempted by researchers. Of the available methods, chemical control seems to hold the most promise for control of this milfoil. Biological control is largely ineffective, with many typical aquatic herbivores finding the plant unpalatable. Mechanical control is difficult because of the species' ability to regenerate from a small fragment of the original plant and its rapid growth rate, requiring many repeated treatments to control an infestation. There are several chemical treatments that have shown promise, but many do not specifically target milfoil and may damage native aquatic species as well (Cal-IPC 2018).

Parrot's feather milfoil is listed by the CDFA as a C-rated noxious weed, which means "*A pest of known economic or environmental detriment and, if present in California, it is usually widespread. If found in the state, they are subject to regulations designed to retard spread or to suppress at the discretion of the individual county agricultural commissioner. There is no state enforced action other than providing for pest cleanliness*" (CDFA 2016).

Parrot's feather milfoil is given a "high" invasive plant rating by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2018a).

The species was reported to be located 3 mi northwest outside of Camp Far West Reservoir, within Beale Air Force Base (USGS 2018k). The population within the Camp Far West quadrangle is being managed and decreasing (Cal-IPC 2018b).

<u>Eurasian Watermilfoil</u>

Eurasian watermilfoil grows submerged, rooted in mud or sand, with branching stems 12 to 20 ft long that widen towards the root. Its leaves are finely divided, feather-like, 0.5 to 1.5 in. long and whorled in groups of 3 to 6 (commonly 4) around the stem. Its spike of flowers, 1.5 to 3.0 in. long, extends up from water surface, typically pink (DiTomaso et al. 2013).

Watermilfoil grows rapidly in spring (March-April), creating dense mats on the surface of freshwater lakes, ponds, and slow-moving waters (Cal-IPC 2018b). In the early 1990s, it was present, but uncommon, in San Francisco Bay Area's ditches and lake margins, as well as in the Sacramento-San Joaquin Delta (SFEI 2014). The University of Reno reports that in 2002, Eurasian watermilfoil covered over 160 ac of Lake Tahoe (Donaldson and Johnson 2002). Watermilfoil is now widespread throughout California, especially through the Central Valley in the Sacramento River Watershed, its tributaries, and the Delta.

The key factor for the establishment of Eurasian watermilfoil is still water (Donaldson and Johnson 2002). Eurasian watermilfoil reproduction is primarily vegetative via rhizomes, stem fragments, and axillary buds. Some populations produce seeds, although seed reproduction appears to be insignificant (DiTomaso et al. 2013). Watermilfoil can tolerate a wide range of environmental conditions, including low light levels, high or low nutrient waters, and freezing water temperatures. In waters where temperatures do not drop below 50°F, there is little seasonal die-back; high temperatures promote multiple periods of flowering and fragmentation. Eurasian watermilfoil also creates its own habitat by trapping sediment and initiating a favorable environment for further establishment. It is an opportunistic species that prefers disturbed substrates with much nutrient runoff (Cal-IPC 2018b). This watermilfoil can grow on sandy, silty, or rocky substrates, but grows best in fertile, fine-textured, inorganic sediments. The plant will thrive in brackish waters with a salinity of up to 10 parts per thousand. As the plant is easily spread by vegetative fragments, transport on boating equipment plays the largest role in contaminating new water bodies. A single stem fragment hitching a ride on a boat or trailer can spread the plant from lake to lake (Donaldson and Johnson 2002).

Efforts are underway to identify insects which are native to Nevada or California that prey on the plant and help control Eurasian watermilfoil. A North American native milfoil weevil (*Euhrychiopsis lecontei*) has been identified in several studies in other states and Canada as a possible control species. Triploid grass carp may also be an effective biocontrol mechanism; however, grass carp prefer other submerged plants, including native species, to watermilfoil (DiTomaso et al. 2013). Other control techniques for this species includes mechanical removal, herbicide treatment, benthic barriers (such as mats to prevent establishment), and tillage (Cal-IPC 2018b). Mechanical removal can help remove stem densities, but escaped stem fragments can drift to other areas and develop into new plants (DiTomaso et al. 2013). The most effective technique is to prevent its spread to and establishment in new waterbodies.

Eurasian watermilfoil is given a "high" invasive plant rating by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2018a).

The species has been reported to be located 0.5 mi northwest outside of Camp Far West Reservoir(Cal-IPC 2018b). The population within the Camp Far West quadrangle is being managed and decreasing (Cal-IPC 2018b).

<u>Curly Leaf Pondweed</u>

The genus *Potamogeton* contains many widespread, variable species that are difficult to tell apart (Cal-IPC 2018b). All are native to California, except curly leaf pondweed, whose distinguishing characteristic is very wavy (undulate) leaves. Native to Eurasia, Africa and Australia, curly leaf pondweed can grow up to 0.8-in. in length and be found in water as deep as 4.7 in. (DiTomaso et al. 2013).

Most pondweeds reproduce vegetatively from rhizomes or stem fragments. Curly leaf pondweed is unusual as it both flowers and fruits in late spring and early summer, at which time it also produces turions, a wintering bud resembling brown pinecones, that becomes detached and remains dormant at the bottom of the water body it inhabits (Cal-IPC 2018b; DiTomaso et al. 2013). Turions can survive unfavorable conditions. The plants become dormant over the summer and decay, contributing to eutrophic conditions, leaving only their fruits and turions in the waterbody. The turions germinate in late summer or fall, and the plants overwinter as small plants only a few centimeters in size. Growth then continues as the water begins warming in the spring (DiTomaso et al. 2013).

Curly leaf pondweed is widely distributed throughout California, and is found throughout the Central Valley and northern Sierra foothills. The plant's production of both seed and turions makes it resistant to disturbance such as dredging. Their small size allows them to be easily transported attached to waterfowl, boats, or fishing gear (Cal-IPC 2018b).

Laboratory and field studies have found that germination is generally controlled by temperature, light intensity, photoperiod, and anoxic conditions. It grows in the fine substrates and quiet (standing or slow moving) calcium-rich waters of lakes, reservoirs, ponds, rivers, streams, springs, small ponds and ditches and is tolerant of a wide-range of water quality conditions. It can grow in clear to turbid and polluted waters, and in alkaline or brackish waters; and it is tolerant of significant nutrient pollution. The species is shade intolerant (Cal-IPC 2018b).

Effective control of curly leaf pondweed is difficult because of its vegetative reproduction. Mechanical removal can help remove stem densities, but escaped stem fragments can drift to other areas and develop into new plants. Bottom barriers can be used to cover and smother pondweed infestations. Dredging can be used to remove infestations in canals and other waterbodies. Pond drawdowns or canal detwatering may be used to suppress growth of pondweed, but plants can still resprout from rhizomes in moist, cool bottom sediments (DiTomaso et al. 2013). Triploid grass carp (*Ctenopharyngodon idella*) have also been used as a biological control mechanism, however these fish do not selectively feed on non-native plants and a permit is required by CDFW for possession and use of these fish in California. Broadcast chemical control has proved to be effective, but can damage native species (Cal-IPC 2018b).

Curly leaf pondweed is rated as a "moderate" invasive plant by the California Invasive Plant Council (Cal-IPC), which means the "*species has substantial and apparent - but generally not severe - ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2018b).

Curly leaf pondweed has been located about 12 miles south of the Project in in Nevada Placer County and (in neighboring Wolf quadrangle), but has not been documented from Camp Far West Reservoir (Cal-IPC 2018a).

Zebra and Quaaga Mussels

Zebra Mussel

Zebra mussel is a small (around 0.2-in.), freshwater mollusk, native to the Black, Caspian and Azov seas. Ballast water discharge from a single commercial cargo ship into the Great Lakes in 1988 is responsible for their introduction into the U.S. Since then, larval drift and recreational and commercial boating have facilitated their spread (USGS 2018d).

Zebra mussel can inhabit freshwater lakes, reservoirs and streams and colonize any stable substrate. It can also settle on submerged plants and be transported with them on bait buckets, fishing gear or boats. The mussel can cause damage to hydroelectric facilities and ecosystems once they invade a system. It clogs water intakes and fish screens, as well as impede recreation opportunities by growing on recreation facilities (Forest Service 2016).

In addition, zebra mussel consume large quantities of microscopic plants and animals, which are the basis of native communities, and thus, lead to the disturbance of the natural ecosystem, harming plants and wildlife (USFWS 2011). A single female can lay 40,000 eggs in a single reproductive cycle and up to one million in a spawning season (USGS 2018d).

Zebra mussel can tolerate only very low salinity (USGS 2018d). Currently, the best scientific data indicates that if calcium levels are low (i.e., less than 12 mg/L), introduced adult zebra mussels will not survive and veligers will not develop (Claudi and Prescott 2011). Additionally, marginal sites can be determined for their ability to support zebra mussels by the concentration of calcite. A minimum calcite value of ~0.9 is necessary for supporting zebra mussels long-term (Prescott et al. 2014). There are other water quality parameters that appear to also limit the ability of zebra mussel adults to survive and veligers to successfully develop, including pH, hardness and water temperature. Calcium carbonate solubility increases as pH decreases. In spite of adequate calcium, if the pH is low (i.e., less than 7.3 units) shells will become thin as they lose calcium to the external environment (Claudi and Prescott 2011). However, initial introduction can occur under a broader range of conditions.

Extensive research is currently being conducted on the management of zebra mussel once it has invaded a waterbody and although there are promising leads; prevention is the only effective management strategy (USGS 2018d). Research on natural enemies, both in Europe and North America, has focused on predators, particularly birds (i.e., 36 species) and fish (i.e., 53 species that eat veligers and attached mussels). The vast majority of the organisms that are natural enemies in Europe are not present in North America. Ecologically similar species do exist; however, they have not been observed preying on zebra mussel at levels that limit populations. In California, native and non-native species predators include redear sunfish (*Lepomis microlophus*), smallmouth bass (*Micropterus dolomieu*) diving ducks and crayfish (Hoddle 2011). At the San Justo Reservoir, the United States Department of the Interior, Bureau of Reclamation is conducting an experiment to eradicate the zebra mussel infestation using muriate of potash. As of December 2017, an experiment had been conducted to determine the response of the mussel to different doses. Future plans include treating all of San Justo Reservoir when funding is available (USBR 2017b).

The Federal Lacey Act (18 U.S.C. 42) lists zebra mussel as injurious wildlife, whose importation, possession, and shipment within the U.S. is prohibited. If found, any zebra mussel brought into the U.S. will be promptly destroyed or exported by the USFWS at the cost of the importer.

Under C.C.R. 14 § 671(c)(10), zebra mussel is listed as a Restricted Species, which means it is "unlawful to import, transport, or possess (zebra mussels)…except under permit issued by the department." Additionally, pursuant to this regulation, all species of *Dreissena* are termed "detrimental," which means they pose a threat to native wildlife, the agricultural interests of the state, or to public health or safety.

In addition, F.G.C. §§ 2301 and 2302 provide specific regulations on dreissenid mussels, including zebra mussel. F.G.C. § 2301 states that nobody shall: "possess, import, ship, or transport in the state, or place, plant, or cause to be placed or planted in any water within the state, dreissenid mussels." This law gives the director of CDFW, or his or her designee, the right to conduct inspections of conveyances, order conveyances to be drained, impound or quarantine conveyances, and close or restrict access to conveyances to prevent the importation, shipment, or transport of dreissenid mussels. Additionally, F.G.C. § 2301 requires a public or private agency that operates a water supply to prepare and implement a plan to control or eradicate dreissenid mussels if detected in their water system. This law also requires any entity which discovers dreissenid mussels to immediately report the finding to CDFW.

Pursuant to F.G.C. § 2302, any person, or Federal, state, or local agency, district, or authority that owns or manages a reservoir where recreational, boating, or fishing activities are permitted, shall: 1) assess the vulnerability of the reservoir for introduction of dreissenid mussels; and 2) develop and implement a program designed to prevent the introduction of dreissenid mussels. At a minimum, the prevention program shall include: public education, monitoring, and management of the recreational, boating, and fishing activities that are permitted. As of 2017, the CDFW has developed a Guidance for Developing a Dreissenid Mussel Prevention Program to include all the requisite pieces of the program (CDFW 2017b). Per the regulations, SSWD drafted a Dreissenid Mussel Vulnerability Assessment in May 2019 for submission to the CDFW. This document includes a prevention program, which features public education and a monitoring program for the dreissenid mussels. The prevention program will include posted signs and pamphlets, which will describe how to clean boats and not to use boats between different waterbodies without cleaning and/or completely drying them out. As the prime vector for the introduction and spread of AIS, this will help prevention the introduction and spread of more than just zebra mussel. This document has been submitted to the CDFW.

The closest current known location of zebra mussel to the Project Area is the currently-closed San Justo Reservoir in California, approximately 200 mi south of the Project (USBR 2017b). There are no other known zebra mussel occurrences in California or Nevada (USGS 2018e).

Quagga Mussel

Quagga mussel is a small (up to 1.6 in.) freshwater mollusk, native to the Dnieper River drainage of Ukraine and Ponto-Caspian Sea. Ballast water discharge from transoceanic liners carried the mussel to North America, and larval drift and recreational and commercial boating have facilitated their spread. Quagga mussel was first found in the U.S. in 1989 in the Great Lakes and have since moved west (USGS 2017).

Quagga mussel can inhabit freshwater lakes, reservoirs and streams and colonize soft and hard substrates. Like zebra mussel, quagga mussel can cause tremendous damage to hydro facilities and aquatic ecosystems once they invade a system. It clogs water intakes and fish screens, as well as impede recreation opportunities by growing on recreation facilities (USGS 2017). Quagga mussels, like zebra mussels, consume large quantities of microscopic plants and animals, which are the basis of native communities, and thus, lead to the disturbance of the natural ecosystem, harming plants and wildlife (USFWS 2011); and they cannot survive in water with salinity over 5 parts per thousand (USGS 2017). Management of quagga mussel is similar to that described above for zebra mussel.

Like zebra mussel, quagga mussel is listed as Restricted under C.C.R. 14 Section 671 (c)(10), regulated under F.G.C. Sections 2301 and 2302. SSWD's May 2019 draft Dreissenid Mussel Vulnerability Assessment covers both zebra and quagga mussels.

In California, quagga mussels are in Southern California, with the closest occurrence to the Project approximately 500 mi south (USGS 2018f).

3.3.3.1.3 Aquatic Resources of the Bear River Area

Information regarding aquatic resources in the Project Vicinity is provided below by: 1) immediately upstream of the Project (NID's Lake Combie to Camp Far West Reservoir); 2) within Camp Far West Reservoir; and 3) from Camp Far West Dam to the Feather River (i.e., lower Bear River). Information regarding mercury in fish, including fish ingestion advisories is discussed in Section 3.3.2.1.4 of this Exhibit E.

Upstream of the Project

Fish

Table 3.3.3-7 lists 12 fishes that are known or suspected to occur in the Bear River upstream of Camp Far Reservoir. For the most part, the fish assemblage is composed of native warmwater species.

Table 3.3.3-7. Fish species know to occur or with the potential to occur upstream, within, and downstream of the Project in alphabetical order.

Common Name	Scientific Name	Status	Native / Introduced	Upstream of Camp Far West Reservoir	In Camp Far West Reservoir	Downstream of Camp Far West Reservoir
American shad	*Alosa sapidissima*	--	I	NR	O	P
Black bullhead	*Ameriurus melas*	--	I	NR	O	NR
Black crappie	*Pomoxis nigromaculatus*	--	I	NR	O	NR
Bluegill	*Lepomis macrochirus*	--	I	NR	O	O
Brown bullhead	*Ameriurus nudbulosus*	--	I	NR	O	NR
Brown trout	*Salmo trutta*	--	I	NR	O	NR
Channel catfish	*Ictalurus punctatus*	--	I	NR	O	O
Chinook salmon	*Oncorynchus tshawytscha*	NMFS-S, CSC	N	NA	NA	O
Common carp	*Cyprinus carpio*	--	I	NR	O	O
Common shiner	*Luxilus cornutus*	--	I	NR	NR	O

Table 3.3.3-7. (continued)

Common Name	Scientific Name	Status	Native / Introduced	Upstream of Camp Far West Reservoir	In Camp Far West Reservoir	Downstream of Camp Far West Reservoir
Goldfish	*Carassius auratus*	--	I	NR	O	O
Green sturgeon	*Acipenser medirostris*	FT	N	NA	NA	P
Green sunfish	*Lepomis cyanellus*	--	I	NR	O	O
Hardhead	*Mylopharodon conocephalus*	CSC	N	P	O	P
Inland silverside	*Menidia beryllina*	--	I	NR	O	O
Largemouth bass	*Micropterus salmoides*	--	I	NR	O	O
Steelhead / Rainbow trout	*Oncorynchus mykiss*	FT[1]	N	O	P	O
Mosquitofish	*Gambusia affinis*	--	I	NR	NR	O
Pacific lamprey	*Entosphenus tridentatus*	--	N	NA	NA	O
Prickly sculpin	*Cottus asper*	--	N	P	P	O
Pumpkinseed	*Lepomis gibbosus*	--	I	NR	NR	O
Redear sunfish	*Lepomis microlophus*	--	I	NR	O	O
Riffle sculpin	*Cottus gulosus*	--	N	P	P	O
Sacramento hitch	*Lavinia exilicauda*	--	N	P	O	P
Sacramento perch	*Archoplites interruptus*	--	N	P	O	P
Sacramento pikeminnow	*Ptychocheilus grandis*	--	N	O	O	O
Sacramento splittail	*Pogonichthys macrolepidotus*	CSC	N	NA	NA	P
Sacramento sucker	*Catostomus occidentalis*	--	N	O	O	O
Sacramento-San Joaquin roach	*Lavinia s. symmetricus*	CSC	N	P	P	P
Smallmouth bass	*Micropterus dolomieu*	--	I	O	O	O
Speckled dace	*Rhinichthys osculus ssp.*	--	N	P	P	P
Spotted bass	*Micropterus punctulatus*	--	I	O	O	O
Striped bass	*Morone saxitilis*	--	I	NR	O	P
Threadfin shad	*Dorosoma petenense*	--	I	NR	O	NR
White sturgeon	*Acipenser transmontanous*	CSC	N	NA	NA	P
White catfish	*Ameiurus catus*	--	I	NR	O	O
White crappie	*Pomoxis annularis*	--	I	NR	O	O
	Subtotal	*7*	--	*12 – 10 Native, 2 Introduced*	*29 – 10 Native, 19 Introduced*	*33 – 15 Native, 18 Introduced*
	Total	**37 Species**				

Sources: CDFW 2012b, ECORP 2014, CDFW unpublished data
Key: O = observed, P = potential to occur (based on available information), NR = no record, NA = outside of historic range; N = Native; I = Introduced, NMFS-S = NMFS Species of Concern, CSC = California Species of Special Concern, FT = Threatened under ESA
[1] The anadromous form of *O. mykiss* is federally threatened, although the resident form is not recognized under this listing.

Yardas and Eberhart (2005) identified flow-related improvement needs and opportunities along with identifying key challenges in the reach between Camp Far West Reservoir and NID's Lake Combie. They concluded that contemporary conditions in this section of the Bear River are such that ecological justifications for improved flows are limited, especially when compared to the lower Bear River or the various foothill streams that continue to support anadromous fish. The authors state that colder water temperatures due to improved summer/fall flows may help to reduce the potential for mercury methylation in this reach and Camp Far West Reservoir, but could also lead to potential conflicts with non-native fisheries. Yardas and Eberhart also noted that any change to flows would require the development of multiple agreements and understandings with various agencies, companies, districts, and private water rights holders.

In addition, Yardas and Eberhart (2005) cite John Hiscox (CDFW biologist, retired) who states that the reach between Lake Combie and Camp Far West Reservoir is reputed to be a renowned area for bass fishing. He surmises during high flow events, game fish likely wash into the river from stocked ponds on private property. Mr. Hiscox states this reach is predominantly located in a deep canyon such that improved flows would likely provide few riparian benefits, and that the reach is predominantly private land holdings and provides few opportunities for public access. Mr. Hiscox speculated that flow improvements below Combie Dam may result in both operational and structural improvement needs.

The North Central Region (NCR) (CDFW 2012a) conducted fish community surveys in October 2011 including two locations in the Bear River: 1) upstream of Camp Far West Reservoir (BR 1); and 2) downstream of Lake Combie (BR 2). The fish community surveys focused on collecting reconnaissance level fish community data utilizing single or multiple pass depletion electrofishing methods. Data relative to species composition, temporal and spatial distribution, and presence or absence of species were collected.

At the sampling location upstream of Camp Far West Reservoir (BR1), a total of 54 fish representing four species was collected during the survey. Species collected were represented by smallmouth bass (n=26, 48.1%), Sacramento sucker (n=21, 38.9%), Sacramento pikeminnow (n=5, 9.3%) and rainbow trout (n=2, 3.7%). Only six smallmouth bass were collected at the sampling location downstream of Lake Combie Dam (BR2).

At the request of NID, ECORP Consulting, Inc. (ECORP) (ECORP 2014) conducted reach assessments within an approximately 5.5 mi section of the Bear River from Lake Combie to Wolf Creek to define and understand the aquatic and sediment resources. A total of 50 smallmouth bass and two spotted bass (*Micropterus punctulatus*) were observed in mid-channel pool and flatwater habitats. Most (78%) of the smallmouth bass were young-of-year and the two spotted bass were in the 1+ age class.

Benthic Macroinvertebrates

As part of ECORP's (2014) study, benthic macroinvertebrate (BMI) samples were collected and identified. In general, Ephemeroptera (EPT) taxa (mayflies, stoneflies, caddisflies), which are important prey items for fish, were present in relatively low quantity. There was also a greater abundance of tolerant species (e.g. blackflies) than intolerant species (e.g. midges), indicating the Bear River is a warm-water system with more environmental stressors. When compared with other area rivers (South Fork American River, North Fork Mokelumne River, and Middle Fork Yuba River), the Bear River in the area examined by ECORP had the lowest species diversity (i.e. taxa richness) and the lowest quantity of EPT taxa.

In 2013, one sample collection was conducted in the Bear River upstream of Camp Far West Reservoir, near Little Wolf Creek (RM 24.0), as part of the Surface Water Ambient Monitoring Program (SWAMP) Statewide Perennial Streams Assessment (SWRCB 2013). While the data provided did not include any BMI metric calculations, the 14 orders and 30 families identified during sampling suggest a diverse assemblage of BMIs (Table 3.3.3-8). However, only seven of the 30 families found were from the EPT taxa suggesting a more stressed warm-water system.

Table 3.3.3-8. Orders and families of aquatic macroinvertebrates that were found at one location in the Bear River (upstream of the Project).

Order	Amphipoda (scuds)	Basommatophora (snails)	Coleoptera (aquatic beetles)	Odonata (dramsel and dragonflies)	Trombidiformes (mites)	Hemiptera (true bugs)
Family	Hyalellidae	Planorbidae	Elmidae	Coenagrionidae	Hygrobatidae	Naucoridae
	Crangonyctidae	Physidae	Psephenidae	--	Torrenticolidae	--

Table 3.3.3-8. (continued)

Order	Ephemeroptera (mayflies)	Veneroida (clams)	Rhynchobdellida (leeches)	Lepidoptera (aquatic moths)	Megaloptera (hellgrammites)	Hoplonemertea (worms)
Family	Caenidae	Corbiculidae	Glossiphoniidae	Pyralidae	Corydalidae	Tetrastemmatidae
	Baetidae	--	--	--	--	--
	Leptohyphidae	--	--	--	--	--
Order	**Diptera (true flies)**	**Trichoptera (caddisflies)**	--	--	--	--
Family	Ceratopogonidae	Helicopsychidae	--	--	--	--
	Chironomidae	Hydroptilidae	--	--	--	--
	Ceratopogonidae	Hydropsychidae	--	--	--	--
	Simuliidae	Philopotamidae	--	--	--	--
	Empididae	Leptoceridae	--	--	--	--

Source: SWRCB 2013.

Camp Far West Reservoir

Fish

Camp Far West Reservoir supports a warmwater fishery, primarily for bass. Table 3.3.3-7 lists 29 fishes that are known or suspected to occur in Camp Far West Reservoir, two-thirds of which are introduced species.

Since Camp Far West Reservoir's enlargement in 1963, stocking of warmwater game fish species by CDFW has occurred. Largemouth bass (*Micropterus salmoides*), smallmouth bass, redear sunfish, white crappie (*Pomoxis annularis*), and channel catfish (*Ictalurus punctatus*) were the first species stocked in the reservoir by CDFG. In 1965, CDFG decided to create a striped bass (*Morone saxatilis*) sport fishery in Camp Far West Reservoir. Stocking records and memoranda between CDFG employees indicated that the striped bass fishery never took hold in the reservoir. In the late 1960s, CDFG's stocking of striped bass ceased and CDFG's efforts shifted to focus on improving the smallmouth bass fishery. Limited available data documented fish survey and stocking records from 1964 through 1985, with some missing years, were obtained from CDFW and are summarized in Table 3.3.3-9 (CDFG unpublished data). There is currently no stocking in Camp Far West Reservoir by SSWD or any Resource Agency.

Table 3.3.3-9. Camp Far West Reservoir stocking records summary from 1964 to 1985, with missing years excluded from row entries.

Year	Common Name	Scientific Name	Lifestage	Quantity (pounds)
1964	Largemouth bass	*Micropterus salmoides*	NA[1]	60,734
	Smallmouth bass	*Micropterus dolomieu*	NA	8,098
	Redear sunfish	*Lepomis microlophus*	NA	12,000
	White crappie	*Pomoxis annularis*	NA	249
	Channel catfish	*Ictalurus punctatus*	NA	10,000
1966	Smallmouth bass	*Micropterus dolomieu*	Fry	18,500
	Striped bass	*Morone saxitilis*	NA	18,707
1967	Smallmouth bass	*Micropterus dolomieu*	Fry, Fingerlings	24,000
	Striped bass	*Morone saxitilis*	NA	23,835
1973	Smallmouth bass	*Micropterus dolomieu*	Fry	1,500,000
1976	Smallmouth bass	*Micropterus dolomieu*	Yearlings	5,050
1978	Smallmouth bass	*Micropterus dolomieu*	Yearlings	5,050
1979	Smallmouth bass	*Micropterus dolomieu*	NA	430
	Channel catfish	*Ictalurus punctatus*	NA	4,030

Table 3.3.3-9. (continued)

Year	Common Name	Scientific Name	Lifestage	Quantity (pounds)
1980	Smallmouth bass	*Micropterus dolomieu*	NA	4,300
1985	Spotted bass	*Micropterus punctulatus*	Adults	40
Total				7 Species 1,659,023 Pounds

Source: CDFG unpublished data.
[1] Information not available from CDFW.

In addition to the species listed in Table 3.3.3-9, CDFW records indicated that white catfish (*Ameiurus catus*) and threadfin shad (*Dorosoma petenense*) were stocked prior to 1980, but no additional details were available (CDFW unpublished data).

Internal memoranda between CDFG staff in the 1970s and 1980s also indicated the presence of 11 fishes in Camp Far West Reservoir, not stocked by CDFW, including: 1) bluegill; 2) green sunfish (*L. cyanellus*); 3) Sacramento perch; 4) brown bullhead (*Ameiurus nebulosus*); 5) black bullhead (*A. melas*); 6) common carp (*Cyprinus carpio*); 7) Sacramento hitch; 8) hardhead; 9) Sacramento sucker; 10) American shad (*Alosa sapidissima*) and; 11) Sacramento pikeminnow.
More recently, in April 2012, CDFG (CDFG 2012b) conducted boat electrofishing surveys at nine sites in Camp Far West Reservoir. The total numbers of individuals for each species are summarized is Table 3.3.3-10, but no other information was available.

Table 3.3.3-10. CDFG 2012 Camp Far West Reservoir boat electrofishing summary of capture in descending order of abundance.

Common Name	Scientific Name	Individuals Captured
Spotted bass	*Micropterus punctulatus*	446
Bluegill	*Lepomis macrochirus*	65
Sacramento sucker	*Catostomus occidentalis*	51
White catfish	*Ameiurus catus*	20
Channel catfish	*Ictalurus punctatus*	13
Inland silverside	*Menidia beryllina*	10
Green sunfish	*Lepomis cyanellus*	8
Largemouth bass	*Micropterus salmoides*	8
Common carp	*Cyprinus carpio*	7
Smallmouth bass	*Micropterus dolomieu*	6
Redear sunfish	*Lepomis microlophus*	5
Threadfin shad	*Dorosoma petenense*	4
Goldfish	*Carassius auratus*	3
Black crappie	*Pomoxis nigromaculatus*	2
Sacramento perch	*Archoplites interruptus*	1
Brown trout	*Salmo trutta*	1
Total Catch	**--**	**650**
Total Species	**--**	**16**

Source: CDFG 2012b

Lower Bear River

As context for this discussion, in June 2015, October 2016 and August 2017, SSWD evaluated the Bear River between Camp Far West Dam and the Feather River for habitat features and channel characteristics. Meso-habitat types are dominated by pools, short riffles, runs, and long glides. The average gradient of the Bear River is generally less than 0.5 percent, with few falls, cascades, chutes, rapids, step runs, pocket water, or sheet flow habitat types. The substrate of the mapped units in the majority of the channel is dominated by gravel with mostly cobble subdominant. Sand is a minor component though is often the subdominant substrate present. Increasing amounts of exposed bedrock and cobble substrates occur closer to the non-Project diversion dam. Very little silt occurs in the active channel, though the banks are often composed of finer, sandy/silty material. Figure 3.3.3-1 and Table 3.3.3-11 provide the results of this mapping exercise. Additional discussion regarding habitat mapping is provided in Section 3.3.1 of this Exhibit E.

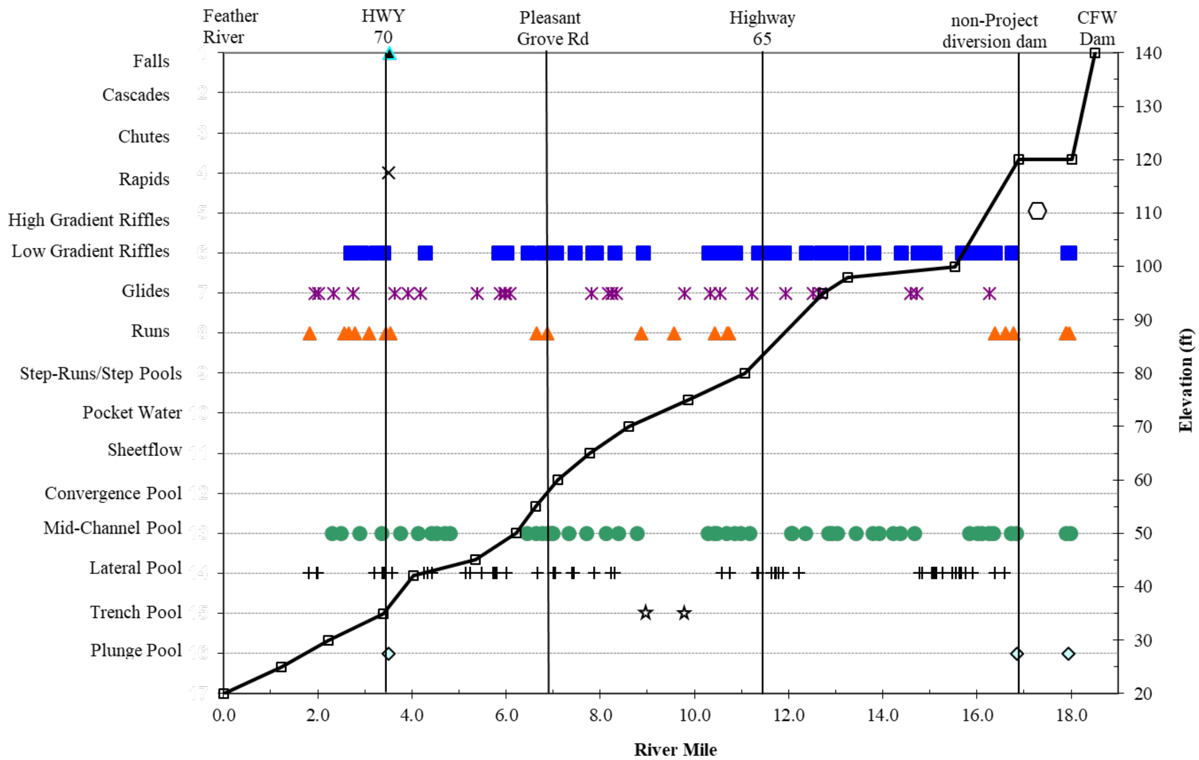


Figure 3.3.3-1. Longitudinal profile and habitat types mapped in the lower Bear River.

Table 3.3.3-11. Dominant, subdominant and bank substrate total length and frequency in the Bear River where measurements could be taken in a safe manner.

Substrate Type	Dominant Substrate		Subdominant Substrate		Bank Substrate	
	Total Length (ft)	Frequency (%)	Total Length (ft)	Frequency (%)	Total Length (ft)	Frequency (%)
Bedrock	696	4	603	4	872	7
Boulder	538	3	0	0	538	4
Cobble	4,893	27	4,577	29	1,257	10
Gravel	10,179	56	5,496	35	3,269	27
Sand	1,753	10	3,849	24	2,996	24
Silt	0	0	1,282	8	3,478	28
Total	**18,059**	**100**	**15,807**	**100**	**12,410**	**100**

LWM was quantified during SSWD's habitat mapping effort. All pieces within the active channel (1.5 yr frequency elevation) that were larger than 4-in diameter at the large end, and longer than 3 ft were tallied. LWM concentration ranged between 18 and 65 pieces per mile (1.1

to 4.0 pieces/100 m), and most of the pieces were within the wetted channel. The highest concentration of LWM was located between Highway 70 and Pleasant Grove bridges, and the lowest concentration was between Highway 65 (RM 11.5) and the CEMEX gravel operation (RM 14.2). The riparian area of the lower Bear River is heavily modified by levees and agricultural modifications, so the LWM recruitment potential is very low and outside of the control of Project operations. Additional discussion of LWM is provided in Section 3.3.1 of this Exhibit E.

Fishes

Table 3.3.3-7 lists 33 fishes that are known or suspected to occur in the lower Bear River, which for the most part are introduced and native warmwater species, with some anadromous salmonids. The most abundant species are centrarchids, occupying all reaches of the lower Bear River. Native species observed included Pacific lamprey, prickly sculpin, Sacramento sucker, Sacramento pikeminnow, and riffle sculpin. Adult Chinook salmon were observed during SSWD's redd surveys and juveniles were observed during the fish population surveys. No adult *O. mykiss* were observed, although a small number of *O. mykiss* parr were observed during the fish population surveys. SSWD did not observe any sturgeon in the lower Bear River during its studies.

SSWD's Fish Population Surveys

As part of its relicensing studies, SSWD partitioned the Bear River into five reaches: 1) Camp Far West Dam to the non-Project diversion dam; 2) the non-Project diversion dam to the Highway 65 Bridge; 3) Highway 65 Bridge to the Pleasant Grove Bridge; 4) the Pleasant Grove Bridge to the Highway 70 Bridge; and 5) Highway 70 Bridge to the Feather River (Table 3.3.3-12).

Table 3.3.3-12. Bear River reach designations.

Reach	Upstream Location	Upstream River Mile	Downstream Location	Downstream River Mile	Distance (River Miles)
1	Camp Far West Dam	18.1	Non-Project Diversion Dam	16.9	1.2
2	Non-Project Diversion Dam	16.9	Highway 65 Bridge	11.4	5.5
3	Highway 65 Bridge	11.4	Pleasant Grove Road Bridge	6.8	4.6
4	Pleasant Grove Road Bridge	6.8	Highway 70 Bridge	3.5	3.3
5	Highway 70 Bridge	3.5	Feather River Confluence	0.0	3.5
				Total	**18.1**

Table 3.3.3-13 provides the specific locations at which SSWD conducted backpack and boat electrofishing, composite snorkel and seine surveys, and eDNA sampling.

Table 3.3.3-13. Methods, dates, and locations of sampling events for Study 3.2.

Reach	Survey Type	River Mile	Date of Survey(s)	Latitude	Longitude
Reach 1	Backpack Electrofishing	17.8	10/27/2017	39.0484111	121.3192528
Reach 1	Boat Electrofishing	17.0	9/10/2018	39.042564	121.330631
Reach 2	eDNA	16.9	2/22/2017, 3/8/2017	39.0417222	121.3322222
Reach 2	eDNA	16.7	2/22/2017, 3/8/2017	39.0394444	121.3347500
Reach 2	Snorkel/Seine	15.0	10/25/2017	39.0233500	121.3544417
Reach 2	Snorkel/Seine	15.0	4/24/2018	39.02234	121.35386
Reach 2	Snorkel/Seine	15.0	5/21/2018	39.02242	121.35387
Reach 2	Snorkel/Seine	15.0	6/21/2018	39.02239	121.35389
Reach 3	eDNA	11.4	2/23/2017, 3/8/2017	38.9996667	121.4072222

Table 3.3.3-13. (continued)

Reach	Survey Type	River Mile	Date of Survey(s)	Latitude	Longitude
Reach 3	Snorkel/Seine	7.8	10/24/2017	38.9879889	121.4692667
Reach 3	Snorkel/Seine	7.8	4/25/2018	38.98764	121.47198
Reach 3	Snorkel/Seine	7.8	5/22/2018	38.98765	121.471918
Reach 3	Snorkel/Seine	7.8	6/20/2018	38.98775	121.472000
Reach 4	eDNA	5.1	3/1/2017, 3/15/2017	38.9783056	121.5166389
Reach 4	Snorkel/Seine	4.5	10/26/2017	38.9736389	121.5244111
Reach 4	Snorkel/Seine	4.5	4/26/2018	38.97362	121.52636
Reach 4	Snorkel/Seine	4.5	5/23/2018	38.960045	121.527953
Reach 4	Snorkel/Seine	4.5	6/19/2018	38.973611	121.526333
Reach 4	eDNA	4.0	3/1/2017, 3/15/2017	38.9740833	121.5349167
Reach 5	eDNA	0.6	2/28/2017, 3/15/2017	38.9434722	121.5709444

Figure 3.3.3-2 through Figure 3.3.3-4 show the locations and detections of fishes where SSWD conducted backpack and boat electrofishing, composite snorkel and seine surveys).

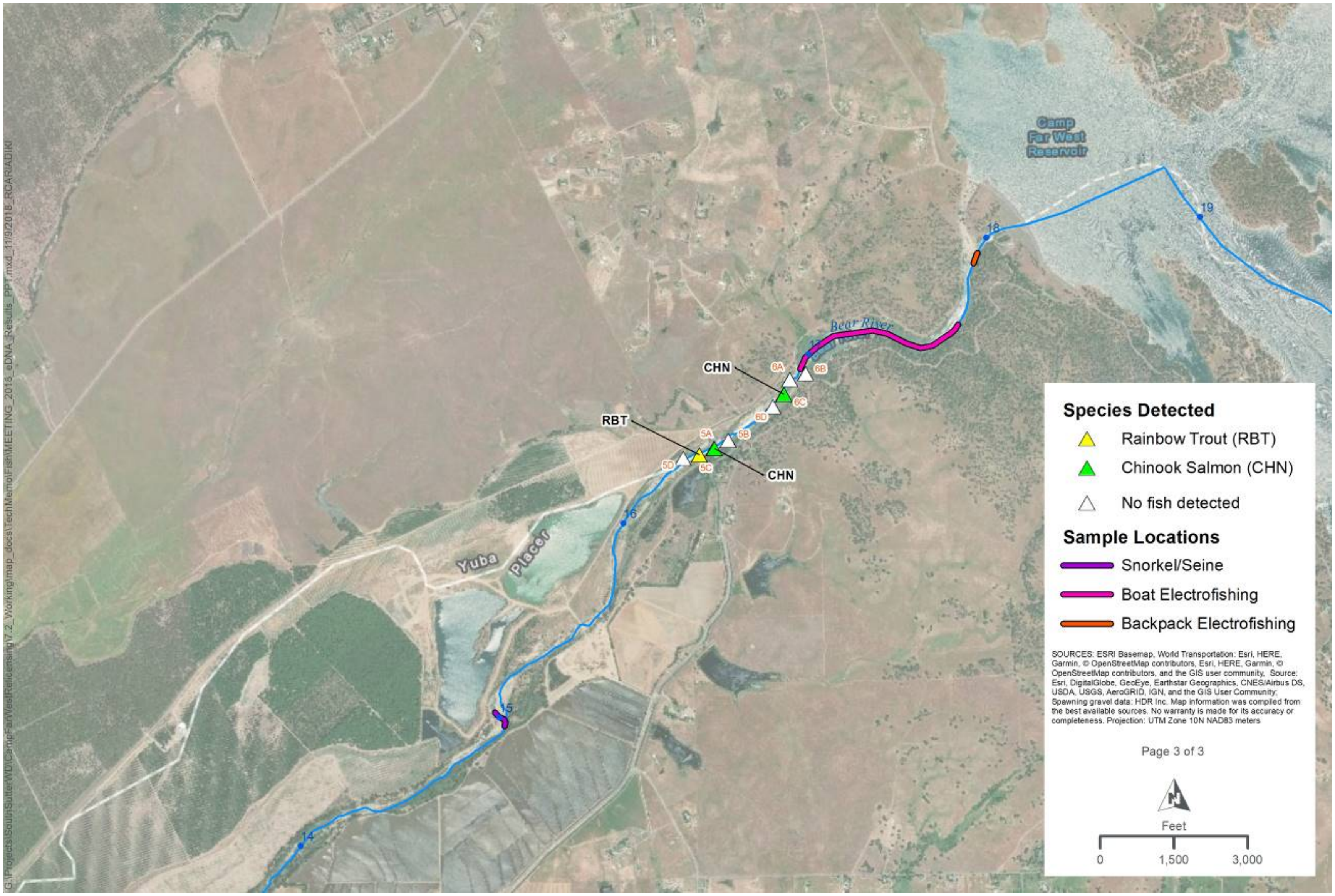


Figure 3.3.3-2. Lower Bear River Reaches 1 and 2 boat electrofishing, backpack electrofishing and snorkeling and seining sampling sites and eDNA detections.

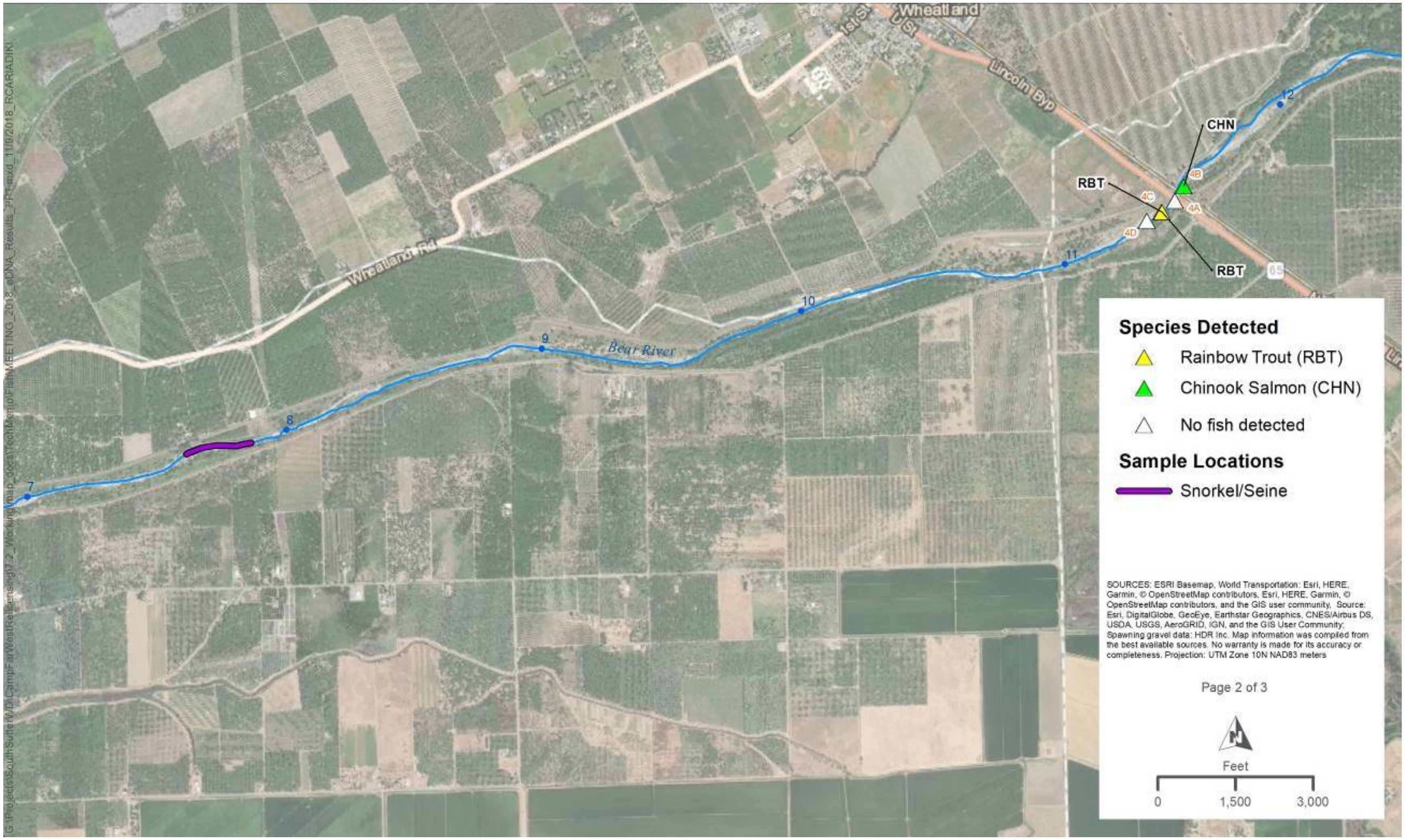


Figure 3.3.3-3. Lower Bear River Reach 3 snorkeling and seining sampling sites and eDNA detections.

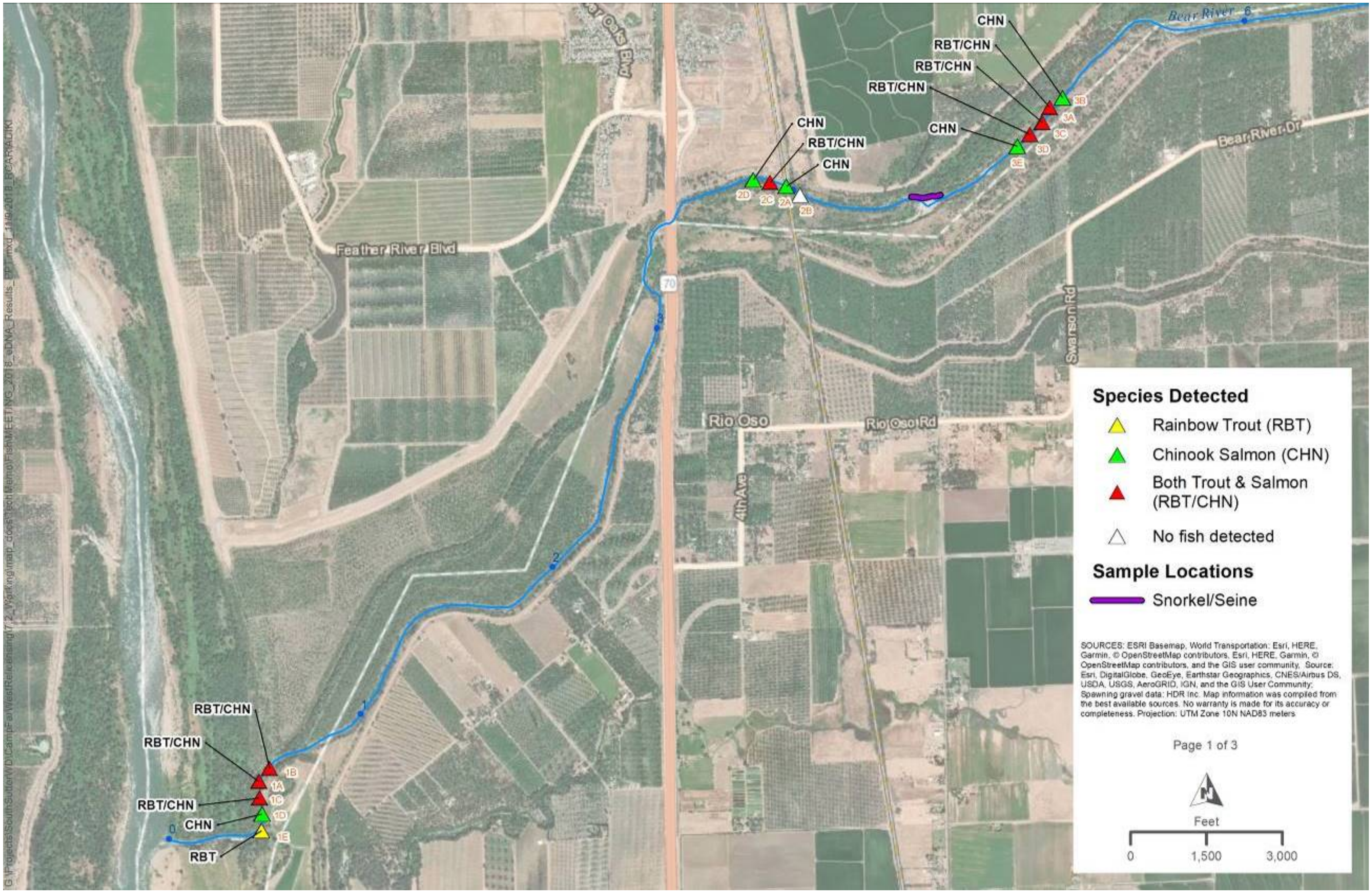


Figure 3.3.3-4. Lower Bear River Reach 4 snorkeling and seining sampling site and eDNA detections in Reaches 4 and 5.

Fish Population Surveys - Reach 1

SSWD found 14 warmwater, non-native fishes and Sacramento sucker, a native coldwater species, in Reach 1 (Table 3.3.3-14). Detailed results are provided below. In addition, 2018 summer observations made in Reaches 2 through 4 as part of water transfer fish surveys on July 24-26 and August 29-31 validated many of the general species guilds with observations of bass/sunfish, suckers, carp, and catfish. Chinook salmon and sturgeon were not observed during the summer survey period.

Table 3.3.3-14. Fishes, in alphabetical order, found in Reaches 1 through 4 during SSWD's relicensing fish population surveys.

Common Name	Scientific Name	Reach 1	Reach 2	Reach 3	Reach 4
Bluegill	*Lepomis macrochirus*	Be, Bo	Sn, Se	Sn	Sn, Se
Centrachid sp. (unknown)	--	--	--	--	Sn
Channel catfish	*Ictalurus punctatus*	Be, Bo	--	--	Sn
Chinook salmon	*Oncorynchus tshawytscha*		Sn, Se, eDNA, R	Sn, Se, eDNA, R	Sn, Se, eDNA, R
Common carp	*Cyprinus carpio*	Bo	--	--	--
Goldfish	*Carassius auratus*	Bo	--	--	--
Green sunfish	*Lepomis cyanellus*	Be, Bo	Se	Sn	Sn, Se
Inland silverside	*Menidia beryllina*	Bo	Se	--	--
Lamprey (ammocete)	*Entosphenus* spp.		Se	--	--
Largemouth bass	*Micropterus salmoides*	Bo	--	--	--
Minnow sp. (unknown)	--	--	Sn	Sn	Sn
Mosquitofish	*Gambusia affinis*	Be	Sn, Se	Sn	Sn, Se
Prickly sculpin	*Cottus asper*	--	Sn	--	--
Pumpkinseed	*Lepomis gibbosus*	--	Se	--	Se
Rainbow trout	*Oncorynchus mykiss*	--	eDNA	Sn, Se, eDNA	eDNA
Redear sunfish	*Lepomis microlophus*	Bo	--		Sn
Rifle sculpin	*Cottus gulosus*	--	--		Se
Sacramento pikeminnow	*Ptychocheilus grandis*	--	Sn, Se	Sn	Sn
Sacramento sucker	*Catostomus occidentalis*	Bo	Sn, Se	Sn	Sn, Se
Shiner spp. (unknown)		Be	--		--
Smallmouth bass	*Micropterus dolomieu*	--	--	Sn	Sn
Spotted bass	*Micropterus punctulatus*	Be, Bo	Sn, Se	Sn, Se	Sn, Se
Sculpin sp. (unknown)		--	Sn		--
White catfish	*Ameiurus catus*	Bo	--		Sn
White crappie	*Pomoxis annularis*	Be	--		--
	Subtotal	*14*	*14*	*10*	*16*
	Total	**25**			

Key: Sn = snorkeling; Be = backpack electrofishing; Bo = boat electrofishing; Se = seining; WT = observed during SSWD's visual surveys related to a 2018 water transfer; eDNA = eDNA sampling targeted Chinook salmon; *O. mykiss*; green sturgeon; and 4) white sturgeon; R = Chinook salmon redd observed.

As observed during the fish population survey, the stream fish population sample site in Reach 1 was represented by a series of riffle, pool, and glide habitat units. The channel and substrate was visibly composed of bedrock with moderate amounts of cobble. Depth was minimal and averaged 0.2 m (Table 3.3.3-15). Few locations in Reach 1 are suitable for backpack electrofishing, since most of this reach is below the inundation elevation of the non-Project diversion impoundment. The site sampled using backpack electrofishing was representative of the short, riverine portion of Reach 1.

Table 3.3.3-15. Habitat characteristics for Reach 1 backpack electrofishing site.

Habitat Characteristics		Reach 1
Timing	Sample date	October 27, 2017
Water Quality	Air temp. (C)	16.0
	Water temp. (C)	12.9
	Dissolved oxygen (mg/l)	9.8
	Conductivity (µS)	88.7
Site Characteristics	Elevation (m msl)	41.1
	Rivermile	17.8
	Site length (m)	83.8
	Average site width (m)	7.2
	Average depth (m)	0.2
	Average Maximum depth (m)	1.0
	Estimated Flow	16 cfs
Habitat Characteristics	Dominant substrate	Bedrock/Cobble
	Sub-dominant substrate	Gravel
	Number of Large Woody Debris Pieces	0
	Suitable spawning gravel (sq ft)	0
	Low-gradient riffle	38%
	% Glide	15%
	% Mid-channel Pool	45%
	% Chute	3%

In the backpack electrofishing site, multi-pass depletion sampling was conducted using two Smith Root LR-24 backpack electrofishers in October 2017. Sampling resulted in the capture of 176 individuals representing seven warmwater, non-native species. Green sunfish and spotted bass were more abundant (n=86 and n=53, respectively). Mosquitofish also represented a large proportion of the catch (24%). Spotted bass showed the broadest range of size classes (Fork Length, FL: 49 to 167mm) and represented the highest biomass (6.7 lbs/ac). Fulton's condition for spotted bass averaged above 1.0, which is considered good. Relative condition was variable with broad ranges for most species (Table 3.3.3-16 and Figure 3.3.3-5).

Table 3.3.3-16. Population summary of backpack electrofishing site in Reach 1.

Summary Metrics		Species						
		Green Sunfish	**Spotted Bass**	**Mosquitofish**	**Bluegill**	**Channel Catfish**	**Shiner spp.**	**White Crappie**
Abundance	No. captured by pass (total)	43-30-13 (86)	42-6-5 (53)	9-11-4 (24)	6-2-2 (10)	0-1-0 (1)	0-1-0 (1)	0-1-0 (1)
	Estimated abundance	104	53	33	10	1	1	1
	95% CI	83-125	51-55	11-55	7-13	1-1	1-1	1-1
	Fish/100m[1]	124.1	63.2	39.4	11.9	1.2	1.2	1.2
	Fish/mi[1]	1,996.8	1,017.6	633.6	192.0	19.2	19.2	19.2
Length (mm)	Range (Average)	32-98 (63)	49-167 (85)	21-50 (36)	52-103 (79)	112	55	56
Weight (g)	Total	396.1	498.1	13	70.1	7.3	1.5	1.3
	Range (Average)	0.4-17.1 (4.6)	1.2-53.7 (9.4)	0.1-1.3 (0.5)	2.1-15.0 (7.0)	7.3	1.5	1.3
	Total estimated weight (g)	479.0	498.1	17.9	70.0	7.3	1.5	1.3
	Weight (g)/100m	472.6	594.2	15.5	83.6	8.7	1.8	1.6
	lbs/ac	6.5	6.7	0.2	0.9	0.1	<0.1	<0.1
	kg/ha	8.0	8.3	0.3	1.2	0.1	0.03	0.02
Condition Factor	Relative – range[1]	0.67-1.42	0.73-1.89	0.51-1.83	0.44-1.22	N/A	N/A	N/A
	Fulton's – range (average)[2]	N/A	0.86-2.21 (1.17)	N/A	N/A	0.52	N/A	N/A

1 Relative condition factor not calculated for species when n=1.
2 Fulton's condition factor not calculated for species without a fusiform body shape, non-game species, or when n=1.

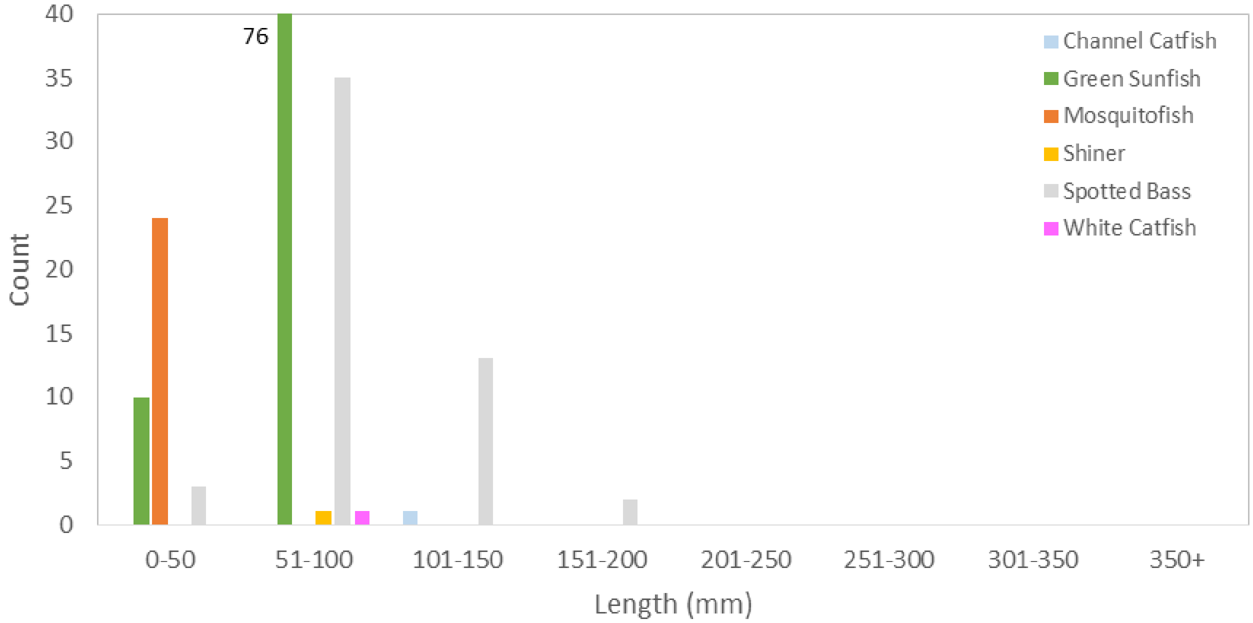


Figure 3.3.3-5. Length-frequency of fishes collected during electrofishing in Reach 1.

The impounded portion of Reach 1 was also sampled in September 2018 by boat electrofishing using a Smith Root 5.0 GPP system. The effort was divided into five unique habitat units defined by their dominant characteristics: 1) shoal and dam; 2) emergent and overhanging vegetation; 3) shoal with artificial structure; 4) drop off and overhanging vegetation; 5) and mid-channel (Figure 3.3.3-6). Average sampled depths ranged from 1.5 to 6 ft, with a maximum encountered depth of 14 ft. Boat electrofishing was completed in all areas where conditions allowed; areas of shallow water, large rocks, or heavy aquatic vegetation were not always suitable for sampling.

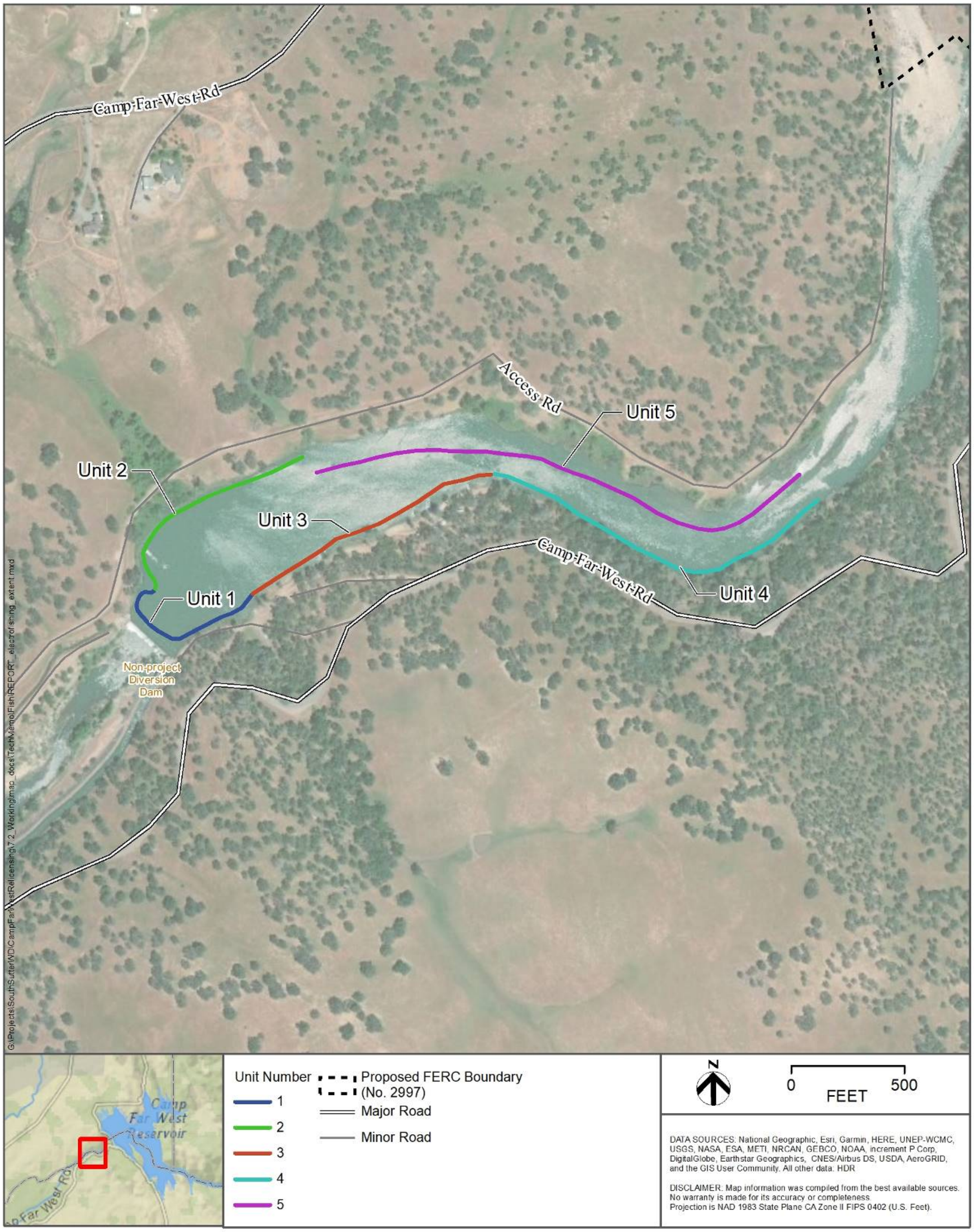


Figure 3.3.3-6. Locations of habitat units sampled during boat electrofishing.

A total of 285 individuals was captured. Bluegill (n=105), spotted bass (n=58), and Sacramento sucker (n=49) were the three more abundant species, respectively. Catch per unit effort (CPUE) (#/min) ranged from 0.8 to 5.39 per unit with an average of 2.8 over all units. Bluegill had the highest capture rate with a CPUE of 1.03 fish per minute (Table 3.3.3-17 and Figure 3.3.3-7). Units 2 and 3 yielded the highest numbers of fishes with 75 and 123 individuals captured, respectively. These units also produced the greatest number of species with 9 each (Table 3.3.3-18 and Figure 3.3.3-8).

Table 3.3.3-17. Population summary of boat electrofished habitat in Reach 1.

Common Name	Scientific Name	# Captured	Length (mm)		Weight (g)		Percent Composition	CPUE (#/min)
			Range	Mean	Range	Mean		
Bluegill	*Lepomis macrochirus*	105	62-162	109	3.7-96.9	28.5	36.8%	1.03
Spotted bass	*Micropterus punctulatus*	58	44-260	137	1.7-230.5	40.5	20.4%	0.57
Sacramento sucker	*Catostomus occidentalis*	49	76-495	412	4.2-1,540.0	913.4	17.2%	0.48
Green sunfish	*Lepomis cyanellus*	34	53-128	82	2.2-42.5	12.9	11.9%	0.33
Readear sunfish	*Lepomis microlophus*	19	70-179	128	16.0-114.9	43.6	6.7%	0.19
Silverside	*Menidia beryllina*	7	36-110	76	1.5-9.0	3.9	2.5%	0.07
Largemouth bass	*Micropterus salmoides*	5	147-400	230	38.0-890.0	279.2	1.8%	0.05
Common carp	*Cyprinus carpio*	4	507-571	539	2,170-3,450	2,670	1.4%	0.04
Goldfish	*Carassius auratus*	2	192-260	226	130-360	245	0.7%	0.02
Channel catfish	*Ictalurus punctatus*	1	482	482	1,160	1,160	0.4%	0.01
White catfish	*Ameiurus catus*	1	147	147	40.0	40.0	0.4%	0.01
Total	**11**	**285**	**--**	**--**	**--**	**--**	**100.0%**	**2.80**

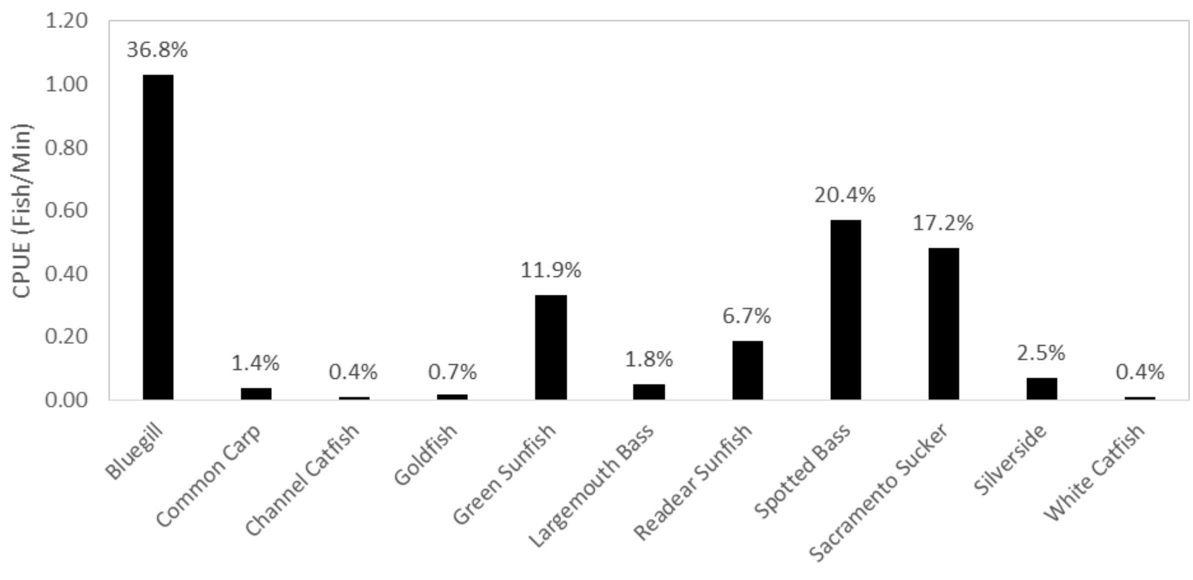


Figure 3.3.3-7. Overall CPUE (fish/min) with composition of species collected during boat electrofishing in Reach 1.

Table 3.3.3-18. Overall catch per unit effort (CPUE in fish/min) by habitat unit during boat electrofishing in Reach 1.

Species	Total Catch	Overall CPUE	Unit 1		Unit 2		Unit 3		Unit 4		Unit 5	
			Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
Bluegill	105	1.03	15	1.43	35	1.93	51	2.23	1	0.03	3	0.21
Spotted Bass	58	0.57	13	1.24	14	0.77	13	0.57	14	0.39	4	0.28
Sacramento Sucker	49	0.48	2	0.19	10	0.55	20	0.88	12	0.33	5	0.35
Green Sunfish	34	0.33	10	0.96	8	0.44	16	0.70	0	0.00	0	0.00
Readear Sunfish	19	0.19	1	0.10	3	0.17	15	0.66	0	0.00	0	0.00
Silverside	7	0.07	1	0.10	2	0.11	2	0.09	2	0.06	0	0.00
Largemouth Bass	5	0.05	0	0.00	1	0.06	4	0.18	0	0.00	0	0.00
Common Carp	4	0.04	1	0.10	0	0.00	1	0.04	0	0.00	2	0.14
Goldfish	2	0.02	0	0.00	1	0.06	1	0.04	0	0.00	0	0.00
Channel Catfish	1	0.01	0	0.00	1	0.06	0	0.00	0	0.00	0	0.00
White Catfish	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	1	0.07
Total Catch	**285**		**43**		**75**		**123**		**29**		**15**	
Overall #/min	**2.8**		**4.11**		**4.13**		**5.39**		**0.8**		**1.06**	

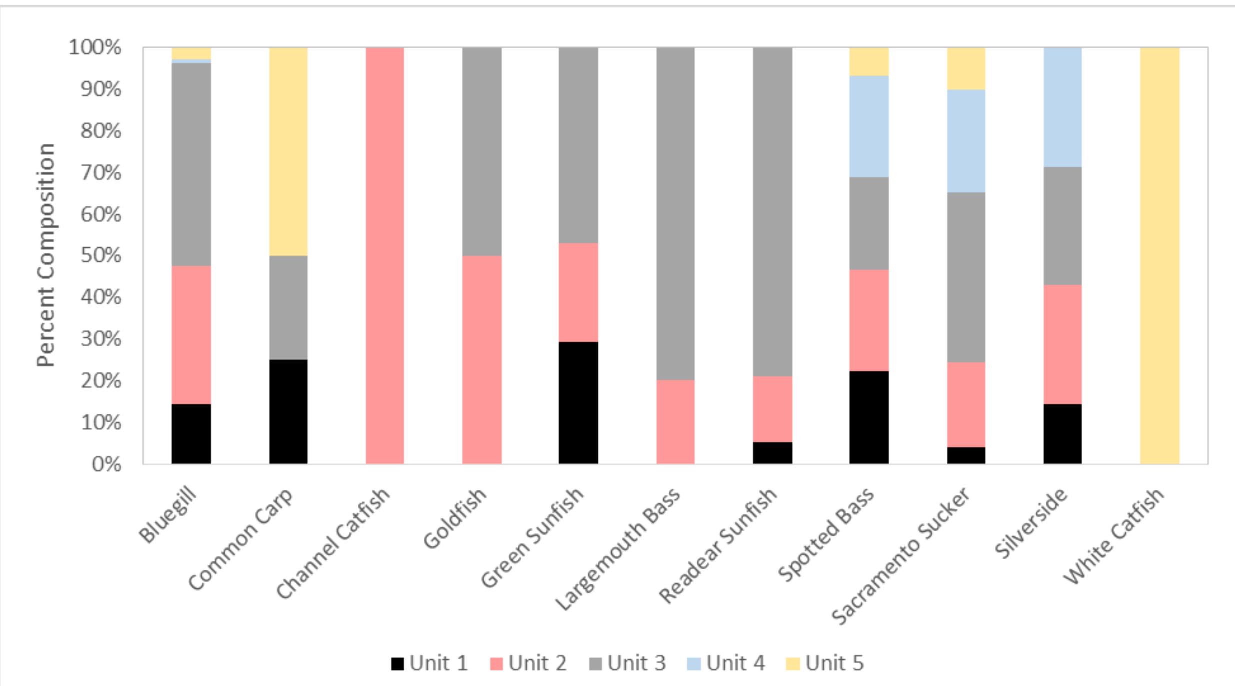


Figure 3.3.3-8. Percent composition by habitat unit during boat electrofishing in Reach 1.

Fish Population Surveys - Reaches 2 through 4

SSWD found 14, 10 and 16 fishes in Reaches 2, 3 and 4, respectively (Table 3.3.3-14). Most of the species were warmwater, introduced species. Detailed results by reach are provided below.

In accordance with Study 3.2, SSWD conducted snorkeling, seining, and eDNA sampling in Reaches 2 through 4. Fish population sample site selection prioritized representing available habitat within the selected reach and considered logistical feasibility. Sites in Reaches 2 and 3 were co-located with the Instream Flow Study sites for data comparability. The site in Reach 4 was located approximately 1 mi upstream of the Highway 70 Bridge where access was available and represented typical habitat. Table 3.3.3-19 describes habitat characteristics as observed during the fish population survey for these sites.

Table 3.3.3-19. Habitat characteristics for snorkel and seine sampling sites in Reaches 2 through 4.

Habitat Characteristics		Reach 2	Reach 3	Reach 4
Timing	Sample date	October 25, 2017 April 24, May 21, June 21, 2018	October 24, 2017 April 25, May 22, June 20, 2018	October 26, 2017 April 26, May 23, June 19, 2018
Water Quality[1]	Air temp. (C)	24.1-28.3 (26.6)	19.7-33.9 (26.1)	20.7-32.2 (26.9)
	Water temp. (C)	12.3-17.1 (15)	14.0-24.5 (19.6)	18.0-25.2 (21.1)
	Dissolved oxygen (mg/l)	9.08-10.70 (10.16)	7.79-10.40 (9.24)	7.40-10.50 (8.49)
	Conductivity (µS)	73.0-86.2 (77.1)	79.0-85.0 (82.7)	113.0-146.0 (130.7)
Site Characteristics[2]	Elevation (m msl)	29.3	21.3	20.1
	Rivermile	15	7.8	4.5
	Site length (m)[3]	139.4	265.6	170.5
	Average site width (m)	12.6	12.3	11.3
	Average depth (m)	0.5	0.3	0.6
	Average Maximum depth (m)	1.4	1.0	1.4
	Estimated Flow Range	16-246 cfs	16-37 cfs[4]	16-36 cfs[4]
Habitat Characteristics	Dominant substrate	Cobble	Gravel	Gravel
	Sub-dominant substrate	Gravel	Sand	Sand
	Fish passage impediments present	No	No	No
	Number of Large Woody Debris Pieces	0	0	0
	Suitable spawning gravel (sq ft)[5]	0-500	3,400-11,270	900-3,440
	% Low-gradient riffle	21	26	4
	% Run	11	6	7
	% Glide	8	15	26
	% Lateral Pool	27	14	0
	% Mid-channel Pool	33	38	47
	% Chute	0	2	>0
	% Trench Pool	0	0	15

1 Water quality parameters for reaches 2 through 4 are presented as a range and (average).
2 Site characteristics averaged overall all sampling events.
3 Site length fluctuated with changes in habitat and flows and is averaged over all sampling events.
4 Flows not available for the April sampling event.
5 Spawning gravel presented as a range through all sampling events.

A three-pass composite snorkel survey and three standardized 10 m seine hauls were completed once at each site in October 2017, and April, May, and June 2018. Seining was not completed in May for Reach 4 and in June for Reaches 3 and 4, because temperatures exceeded 21°C, the maximum allowed under SSWD's CDFW scientific collecting permit. October sampling yielded an assemblage of centrarchids, sculpin, Sacramento pikeminnow, and Sacramento sucker. The spring surveys showed similar species with the addition of salmonids. Sampling results are presented in Table 3.3.3-20 for snorkeling and Table 3.3.3-21 for seining.

Table 3.3.3-20. Population summary of snorkeled habitat units in Reaches 2 through 4.

Species	Abundance						Fork length (mm)	
	# Counted by Pass (Total)	% of Total Fish Counted	Estimated abundance	95% CI	Fish/100 m	Fish/mi	Min (bin)	Max (bin)
OCTOBER 2017								
SNORKELED REACH 2 - 145.4 Meters								
Mosquitofish	131-114-102 (347)	51.8%	116	113-118	80	1,280	0-50	0-50
Spotted Bass	71-76-83 (230)	34.3%	77	75-78	53	849	0-50	151-200
Sacramento Sucker	30-10-8 (48)	7.2%	16	10-22	11	177	0-50	151-200
Sacramento Pikeminnow	13-8-7 (28)	4.2%	9	7-11	6	103	51-100	151-200
Bluegill	4-9-4 (17)	2.5%	6	3-8	4	63	0-50	51-100
SNORKELED REACH 3 - 271.3 Meters								
Spotted Bass	127-162-181 (470)	57.7%	157	152-161	58	929	0-50	251-300
Mosquitofish	77-115-130 (322)	39.6%	107	102-113	40	637	0-50	0-50
Bluegill	7-3-6 (16)	2.0%	5	4-7	2	32	0-50	101-150
Sacramento Pikeminnow	2-2-2 (6)	0.7%	2	2	1	12	151-200	251-300
SNORKELED REACH 4 - 176.8 Meters								
Sunfish species.	45-66-83 (194)	49.6%	65	60-69	37	589	0-50	201-250
Spotted Bass	40-36-30 (106)	27.1%	35	34-37	20	321	0-50	301-350
Mosquitofish	30-30-30 (90)	23.0%	30	30	17	273	0-50	0-50
Sacramento Pikeminnow	0-1-0 (1)	1.0%	1	1.0	1	9	101-150	101-150
APRIL 2018								
SNORKELED REACH 2 - 140.21 Meters								
Chinook Salmon	99-100-76 (275)	98.92%	92	89-95	65	1,052	0-50	51-100
Spotted Bass	0-0-2 (2)	0.72%	1	2	1	8	0-50	51-100
Mosquito Fish	1-0-0 (1)	0.36%	1	1	<1	4	0-50	0-50
SNORKELED REACH 3 - 270.97 Meters								
Chinook Salmon	198-270-282 (750)	75.53%	250	244-256	92	1,485	0-50	101-150
Unknown Minnow	155-0-0 (155)	15.61%	52	27-76	19	307	0-50	0-50
Bluegill	5-9-21 (35)	3.52%	12	7-17	4	69	0-50	151-200
Spotted Bass	6-11-15 (32)	3.22%	11	8-14	4	63	0-50	301-350
Rainbow Trout	10-1-6 (17)	1.71%	6	2-10	2	34	0-50	51-100
Smallmouth Bass	1-0-1 (2)	0.20%	1	1.0	<1	4	>350	>350
Sacramento Pikeminnow	1-1-0 (2)	0.20%	1	1	<1	4	51-100	101-150

Table 3.3.3-20. (continued)

Species	Abundance						Fork length (mm)	
	# Counted by Pass (Total)	% of Total Fish Counted	Estimated abundance	95% CI	Fish/100 m	Fish/mi	Min (bin)	Max (bin)
APRIL 2018 (cont'd)								
SNORKELED REACH 4 - 174.80 Meters								
Chinook Salmon	16-11-7 (34)	75.56%	11	9-14	7	104	0-50	51-100
Bluegill	0-1-7 (8)	17.78%	3	0-8	2	25	0-50	151-200
Spotted Bass	0-0-3 (3)	6.67%	1	0-4	1	9	51-100	101-150
MAY 2018								
SNORKELED REACH 2 - 119.48 Meters								
Unknown Minnow	5-35-35 (75)	45.18%	25	18-32	21	337	0-50	0-50
Chinook Salmon	3-36-33 (72)	43.37%	24	17-31	20	323	51-100	151-200
Spotted Bass	1-1-10 (12)	7.23%	4	0-9	3	54	51-100	301-350
Sacramento Pikeminnow	3-1-0 (4)	2.41%	1	0-4	1	18	51-100	151-200
Bluegill	1-0-1 (2)	1.20%	1	1	1	9	151-200	151-200
Unknown Sculpin	0-1-0 (1)	0.60%	1	1	<1	5	51-100	51-100
SNORKELED REACH 3 - 283.16 Meters								
Unknown Minnow	720-1,000-1,000 (2,720)	87.26%	907	896-917	320	5,153	0-50	0-50
Chinook Salmon	71-62-61 (194)	6.22%	65	63-66	23	368	51-100	151-200
Spotted Bass	46-36-51 (133)	4.27%	44	42-47	16	252	51-100	251-300
Bluegill	8-30-29 (67)	2.15%	22	17-28	8	127	51-100	151-200
Rainbow Trout	0-2-0 (2)	0.06%	1	2	<1	4	101-150	101-150
Smallmouth Bass	0-1-0 (1)	0.03%	1	1	<1	2	101-150	101-150
SNORKELED REACH 4 - 174.80 Meters								
Unknown Minnow	50-0-0 (50)	78.13%	17	3-31	10	153	0-50	0-50
Bluegill	2-6-5 (13)	20.31%	4	2-6	3	40	51-100	51-100
Spotted Bass	0-0-1 (1)	1.56%	1	1	<1	3	51-100	51-100
JUNE 2018								
SNORKELED REACH 2 - 119.48 Meters								
Sacramento Sucker	833-778-833 (2,444)	76.90%	815	813-817	535	8,603	0-50	0-50
Unknown Minnow	50-465-200 (715)	22.50%	238	164-313	156	2,517	0-50	0-50
Spotted Bass	5-7-5 (17)	0.53%	6	5-7	4	60	51-100	>350
Prickly Sculpin	0-1-1 (2)	0.06%	1	1	<1	7	101-150	101-150
SNORKELED REACH 3 - 237.13 Meters								
Spotted Bass	586-539-563 (1,688)	56.95%	563	561-565	237	3,819	0-50	251-300
Unknown Minnow	200-200-125 (525)	17.71%	175	169-181	74	1,188	0-50	0-50
Sacramento Pikeminnow	80-133-186 (399)	13.46%	133	124-142	56	903	0-50	0-50
Bluegill	54-49-66 (169)	5.70%	56	54-59	24	382	0-50	101-150
Sacramento Sucker	13-5-62 (80)	2.70%	27	15-39	11	181	0-50	51-100
Green Sunfish	18-19-15 (52)	1.75%	17	16-18	7	118	51-100	101-150

Table 3.3.3-20. (continued)

Species	Abundance						Fork length (mm)	
	# Counted by Pass (Total)	% of Total Fish Counted	Estimated abundance	95% CI	Fish/100 m	Fish/mi	Min (bin)	Max (bin)
JUNE 2018 (cont'd)								
SNORKELED REACH 3 - 237.13 Meters (continued)								
Smallmouth Bass	8-9-11 (28)	0.94%	9	8-10	4	63	0-50	151-200
Mosquito Fish	10-7-6 (23)	0.78%	8	6-9	3	52	0-50	0-50
SNORKELED REACH 4 - 237.13 Meters								
Unknown Minnow	420-425-300 (1,145)	75.23%	382	375-389	226	3,641	0-50	0-50
Spotted Bass	54-77-70 (201)	13.21%	67	64-70	40	639	0-50	>350
Bluegill	45-47-48 (140)	9.20%	47	46-47	28	445	51-100	151-200
White Catfish	2-3-3 (8)	0.53%	3	2-4	2	25	>350	>350
Sacramento Sucker	2-4-1 (7)	0.46%	2	0-5	1	22	0-50	51-100
Channel Catfish	2-3-0 (5)	0.33%	2	0-5	1	16	251-300	>350
Sacramento Pikeminnow	1-3-1 (5)	0.33%	2	0-4	1	16	0-50	151-200
Redear Sunfish	0-1-3 (4)	0.26%	1	0-4	1	13	51-100	51-100
Smallmouth Bass	0-0-4 (4)	0.26%	1	0-6	1	13	101-150	101-150
Green Sunfish	0-1-1 (2)	0.13%	1	1	<1	6	51-100	101-150
Unknown Centrachid	1-0-0 (1)	0.07%	1	1	<1	3	101-150	101-150

Table 3.3.3-21. Population summary of 10 m standardized seine hauls in Reaches 2 through 4.

Species	Abundance			Fork length (mm)	Weight (g)	Condition Factor	
	# By Pass (Total)	% of Total Fish	CPUE (catch by pass)	Min-Max (Avg)	Min-Max (Avg)	Relative – range	Fulton's – range (average)
OCTOBER 2017							
REACH 2 SEINE (n=47)							
Spotted Bass	0-23-10 (33)	70.2%	11.0	45-152 (61)	1.1-43.9 (3.7)	0.79-0.87	0.86-2.22 (1.22)
Bluegill	0-5-0 (5)	10.6%	1.7	50-58 (54)	1.6-2.4 (1.9)	0.8-1.32	N/A[1]
Green Sunfish	0-3-0 (3)	6.4%	1.0	44-61 (52)	1.6-3.8 (2.5)	1.08-1.17	N/A[1]
Mosquito Fish	0-3-0 (3)	6.4%	1.0	30-41 (35)	0.4-0.6 (0.5)	0.89-1.38	N/A[1]
Sacramento Pikeminnow	2-0-0 (2)	4.3%	0.7	84-88 (86)	5.9-6.1 (6.0)	0.73-1.81	0.90-1.00 (0.95)
Pumpkinseed	0-1-0 (1)	2.1%	0.3	72 (72)	5.1 (5.1)	N/A[1]	N/A[1]
REACH 3 SEINE (n=6)							
Spotted Bass	5-0-1 (6)	100.0%	2.0	125-150 (136)	19.4-37.7 (28.3)	0.85-1.38	0.92-1.49 (1.10)

Table 3.3.3-21. (continued)

Species	Abundance			Fork length (mm)	Weight (g)	Condition Factor	
	# By Pass (Total)	% of Total Fish	CPUE (catch by pass)	Min-Max (Avg)	Min-Max (Avg)	Relative – range	Fulton's – range (average)
OCTOBER 2017 (cont'd)							
REACH 4 SEINE (n=60)							
Mosquitofish	0-43-0 (43)	71.7%	14.3	12-52 (27)	N/A[2]	N/A[1]	N/A[1]
Bluegill	0-3-9 (12)	20.0%	4.0	26-117 (54)	0.3-21.5 (3.3)	0.84-1.23	N/A[1]
Riffle Sculpin	0-1-3 (4)	6.7%	1.3	15-110 (63)	2.0-18.0 (6.7)	N/A[1]	N/A[1]
Spotted Bass	0-0-1 (1)	1.7%	0.3	153 (153)	37.1 (37.1)	0.97[3]	1.04
APRIL 2018							
REACH 2 SEINE[4] (n=140)							
Chinook Salmon	3-42-3-78-11 (137)	97.9%	27.4	30-74 (55.8)	0.3-4.3 (2.2)	0.5-3.2	0.58-4.46 (1.25)
Lamprey Ammocete	0-0-2-0-0	1.4%	0.4	N/A[2]	N/A[2]	N/A[1]	N/A[1]
Inland Silverside	0-0-0-1-0	0.7%	0.2	33 (33)	0.3 (0.3)	N/A[1]	N/A[1]
REACH 3 SEINE (n=183)							
Chinook Salmon	0-0-7-29-147 (183)	100.0%	36.6	45-95 (64.5)	0.9-10.3 (3.6)	0.7-1.6	0.99-1.96 (1.25)
REACH 4 SEINE (n=139)							
Chinook Salmon	0-3-6-70-17 (96)	69.1%	19.2	38-71 (55.2)	0.4-4.4 (2.0)	0.5-1.5	0.61-2.19 (1.11)
Bluegill	0-0-0-1-38 (39)	28.1%	7.8	43-80 (54.1)	1.2-7.1 (2.7)	0.8-1.6	N/A[1]
Mosquitofish	0-0-0-1-2 (3)	2.2%	0.6	36-46 (41.0)	0.3-0.6 (0.5)	0.7-1.0	N/A[1]
Spotted Bass	0-1-0-0-0 (1)	0.7%	0.2	126 (126)	25.5 (25.5)	1.2	1.27
MAY 2018							
REACH 2 SEINE (n=55)							
Chinook Salmon	1-0-49 (50)	90.9%	16.7	58-101 (82.4)	1.8-8.6 (4.7)	0.5-0.9	0.59-0.98 (0.80)
Sacramento Pikeminnow	0-0-3 (3)	5.5%	1.0	109-129 (118.7)	11.0-15.8 (14.0)	0.9-1.1	0.74-0.92 (0.83)
Sacramento Sucker	2-0-0 (2)	3.6%	0.7	76-93 (84.5)	7.0-9.1 (8.1)	1.4-1.9	1.13-1.59 (1.36)
REACH 3 SEINE (n=4)							
Chinook Salmon	0-2-0 (2)	50.0%	0.7	59-67 (63.0)	2.4-3.8 (3.1)	0.9-1.0	1.17-1.26 (1.22)
Rainbow Trout	0-1-0 (1)	25.0%	0.3	74 (74.0)	5.7 (5.7)	N/A[1]	1.41
Spotted Bass	1-0-0 (1)	25.0%	0.3	96 (96.0)	7.1 (7.1)	0.7	0.80
REACH 4 SEINE (n=0)							
No seining conducted per CDFW scientific collecting permit requirements; water temperature was above 21°C							
JUNE 2018							
REACH 2 SEINE (n=147)							
Sacramento Sucker	144-0-0 (144)	98.0%	48.0	17-34 (25.5)	1.1-2.2 (1.7)	0.6-1.9	0.56-2.24 (1.11)
Pumpkinseed	0-1-0 (1)	0.7%	0.3	46 (46.0)	0.6 (0.6)	N/A[1]	N/A[1]
Spotted Bass	0-0-1 (1)	0.7%	0.3	82 (82.0)	4.3 (4.3)	0.7	0.78
Green Sunfish	0-0-1 (1)	0.7%	0.3	76 (76.0)	5.8 (5.8)	1.0	N/A[1]

Table 3.3.3-21. (continued)

Species	Abundance			Fork length (mm)	Weight (g)	Condition Factor	
	# By Pass (Total)	% of Total Fish	CPUE (catch by pass)	Min-Max (Avg)	Min-Max (Avg)	Relative – range	Fulton's – range (average)
June 2018 (cont'd)							
REACH 3 SEINE (n=0)							
No seining conducted per CDFW scientific collecting permit requirements; water temperature was above 21°C							
REACH 3 SEINE (n=0)							
No seining conducted per CDFW scientific collecting permit requirements; water temperature was above 21°C							

[1] Condition factor could not be calculated for single individuals, because lengths and weights were not collected, or body shape was not fusiform.
[2] Lengths and weights were not collected for some species due to concerns of fish health.
[3] Condition factor for spotted bass calculated with fish pooled from all reaches and sampling occasions.
[4] Five seine hauls were completed during April 2018 due to lower visibility and higher flows at the sampling locations.

Figure 3.3.3-9. *O. mykiss* captured in Reach 3 during the May sampling event.

Chinook salmon parr were observed in Reaches 2, 3, and 4 during snorkeling events in April and May 2018. They were also captured during the April and May 2018 seine sampling in the same reaches, except for Reach 4 in May. A total of 416 Chinook salmon parr was captured in April and 52 in May. The lack of Chinook salmon during the June sampling period suggested that rearing fish had migrated downstream. The relative condition of the captured Chinook salmon over all sampling events ranged from 0.5 to 3.2. The Fulton's condition of these fish ranged from 0.58 to 4.46 with averages ranging from 0.80 to 1.25 over all sampling events. *O. mykiss* parr were observed in Reach 3 in April and May 2018. Only one *O. mykiss* parr was captured during the May seine event and is shown in Figure 3.3.3-9.

SSWD's Relicensing eDNA Sampling

SSWD's eDNA sampling targeted four species: 1) Chinook salmon; 2) *O. mykiss*; 3) green sturgeon (*Acipenser medirostris*); and 4) white sturgeon (*Acipenser transmontanous*). Sampling occurred between February 22 and March 1, 2017, and was followed by a second survey that occurred on March 8, 2017 and March 15, 2017 (Table 3.3.3-22). Samples were collected during high flows in the Bear River in accordance with the study plan. Flows ranged from 1,523 to 5,659 cfs throughout sampling events (Table 3.3.3-22). As a result of the high flows, turbidity was also high, which severely limited the volume of water that could be filtered for each sample. Suspended sediment clogged the filter quickly. As a result, the field team used five filters for each sample and recorded the volume of water filtered by each filter. On average, this was approximately 1 liter (total of five filters) for each sample, with filtered amounts ranging from 0.5 L to 1 L across all sites. Discussions with the analysis lab determined that the decreased filtration volumes would not adversely affect the results, given the replication of sites within sampling areas and number of filters used per sample (S. Blankenship [Genidaqs], pers. comm., June 2019). SSWD originally anticipated for the use of one filter per sample location and increased the overall effort to ensure a sufficient volume of water was filtered.

DNA from all samples and controls were extracted using PowerWater Sterivex™ DNA Isolation Kit (Mo Bio Laboratories, Inc.) following the manufacturer's recommended guidelines. A DNA extraction negative control was processed in parallel to ensure sample integrity throughout extraction procedure. DNA extraction controls were processed using the same equipment utilized to extract DNA from all samples. Each sample and all controls were analyzed in triplicate for the presence of the GGS CytB mitochondrial gene using the qPCR primer and probe designed previously. DNA extracted from each sample was analyzed in triplicate with each qPCR replicate consisting of a 10 µl reaction volume. Each 10 µl qPCR reaction was composed of 2x Applied Biosystems TaqMan Universal PCR Master Mix, No AmpErase UNG (Thermo Fisher ABI), 500-900 nM initial primer concentration, 2.5-10 uM initial probe concentration, and 4 µl DNA template. Thermocycling was performed using a Bio-Rad CFX 96 Real time System (Bio-ad Laboratories, Inc.) with the following profile: 10 min at 95°C, 40 cycles of 15 second denaturation at 95°C and 1 min extension at 60°C. Six template control (NTC) reactions were run on the plate with the control sample templates consisting of 4 µl of ultrapure water replacing DNA template within reaction volume. Three positive control reactions consisting of 20 ng/µl target species genomic DNA template were also tested in parallel to ensure consistent PCR performance. All PCR master mixes were made inside an ultraviolet (UV) PCR enclosed workstation. A DNA template was added to the master mix outside of the UV PCR workstation on a dedicated PCR set up workbench. All PCR reactions were conducted on instruments located outside of the main lab in a separate portion of the building. Results of the qPCR reactions were analyzed using BioRad CFX manager v3.1 (Bio-Rad Laboratories, Inc.). A sample was considered positive for the presence of target DNA if any one of the three replicates showed logarithmic amplification within 40 cycles.

Fifty eDNA samples were collected over the two sampling events. Chinook salmon had 17 positive detections throughout all reaches and *O. mykiss* 11 positive detections throughout all reaches (Table 3.3.3-22 and Figures 3.3.3-10 through 3.3.3-12). No green or white sturgeons were detected during either sampling event.

Table 3.3.3-22. Environmental DNA results through both sampling events for *O. mykiss*, Chinook salmon, green sturgeon, and white sturgeon.

Sample Event	Flow (cfs)[1]	Total Samples	Detection by Target Species			
			O. mykiss	**Chinook Salmon**	**Green Sturgeon**	**White Sturgeon**
REACH 2						
1	5,659	7	0	2	0	0
2	1,640	7	1	0	0	0
REACH 3						
1	3,775	4	1	1	0	0
2	1,640	4	1	0	0	0
REACH 4						
1	1,588 to 2,120[2]	9	2	1	0	0
2	1,523	9	2	7	0	0
REACH 5						
1	1,588 to 2,120[2]	5	2	3	0	0
2	1,523	5	2	3	0	0
Total	**--**	**50**	**11**	**17**	**0**	**0**

[1] Flow recorded at USGS gauging station 1142400 – Bear River at Wheatland
[2] Sampling completed over 2 days due to accessibility issues.

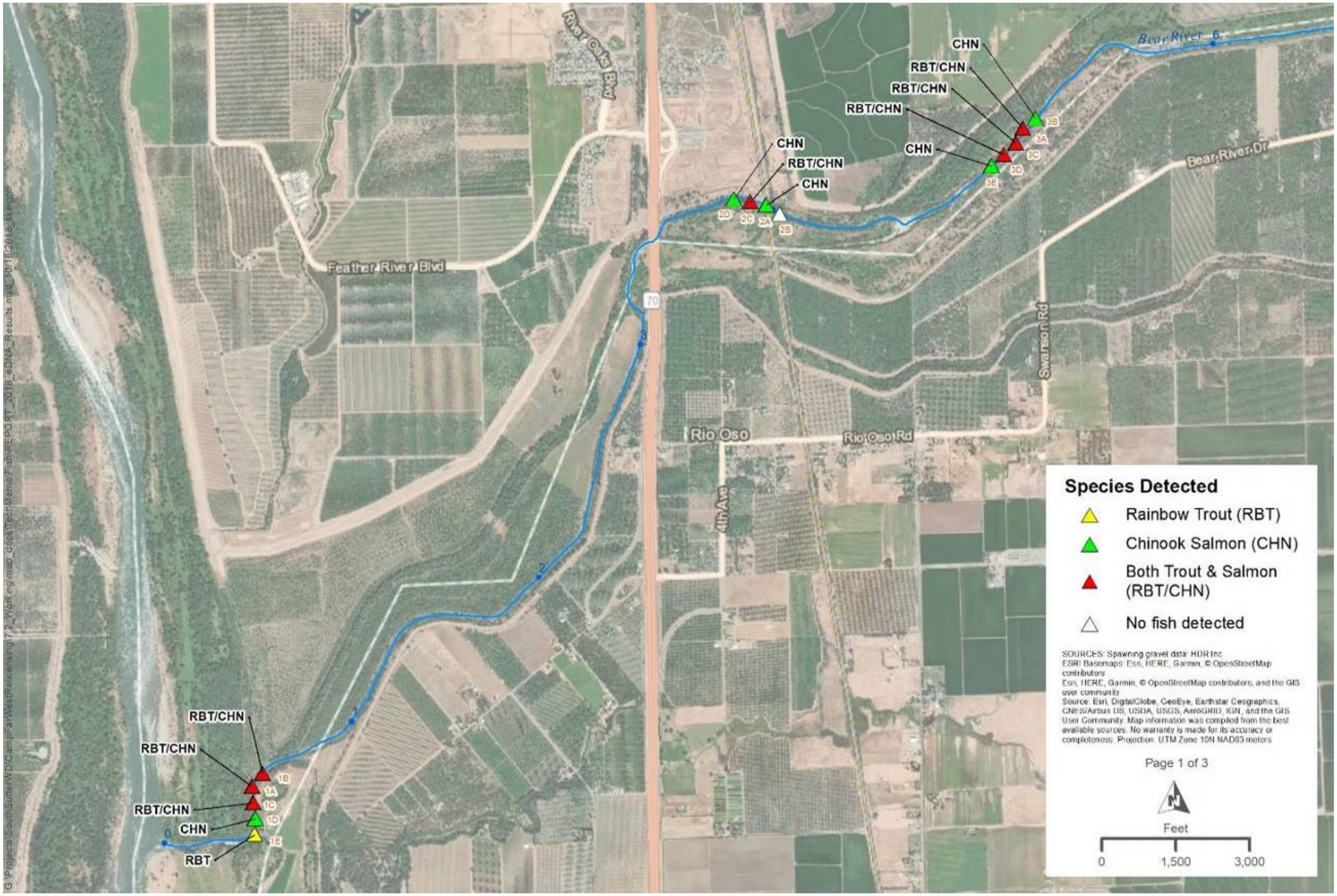


Figure 3.3.3-10. eDNA sampling locations and species detected (Reach 2).

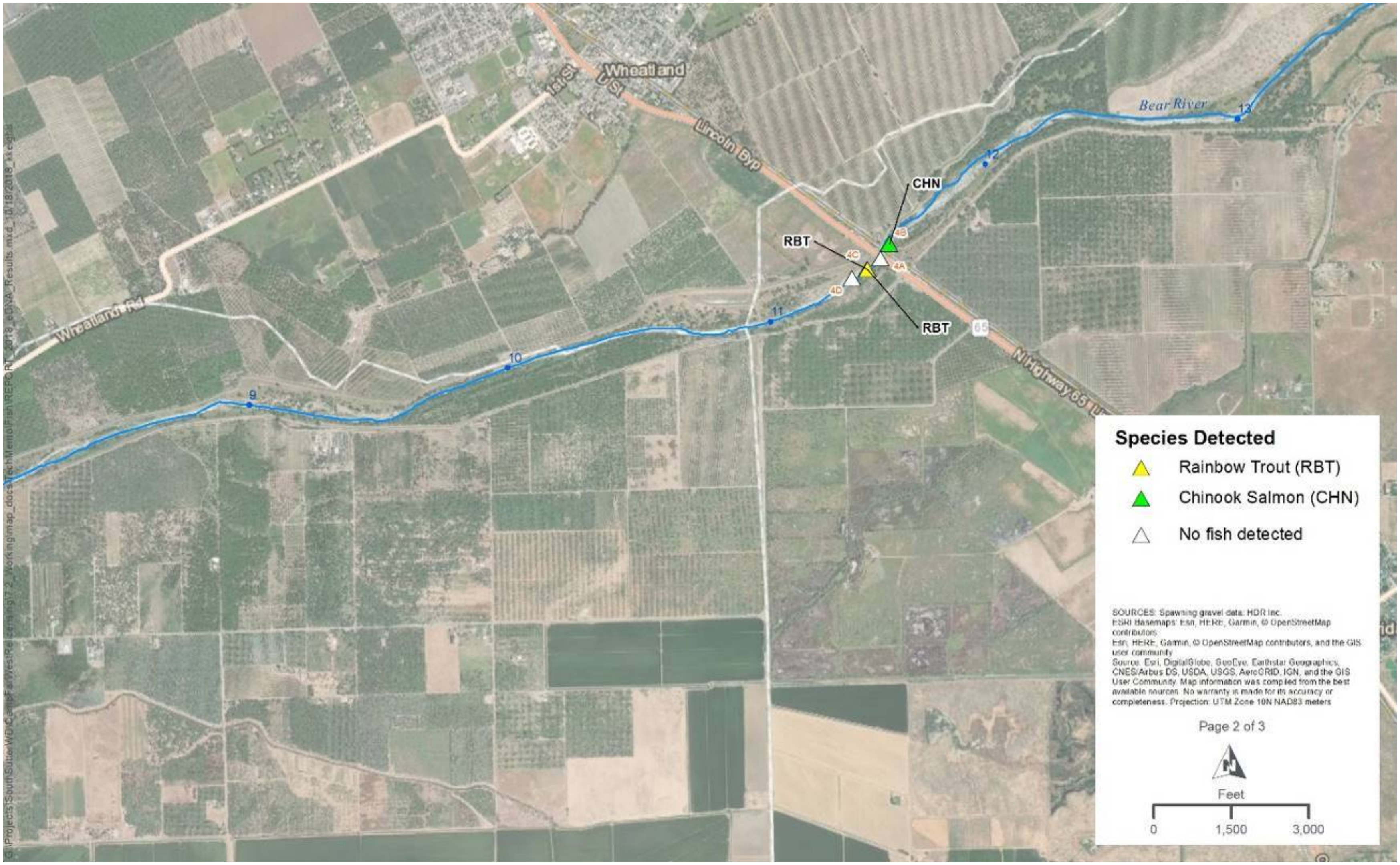


Figure 3.3.3-11. eDNA sampling location and species detected (Reach 3).

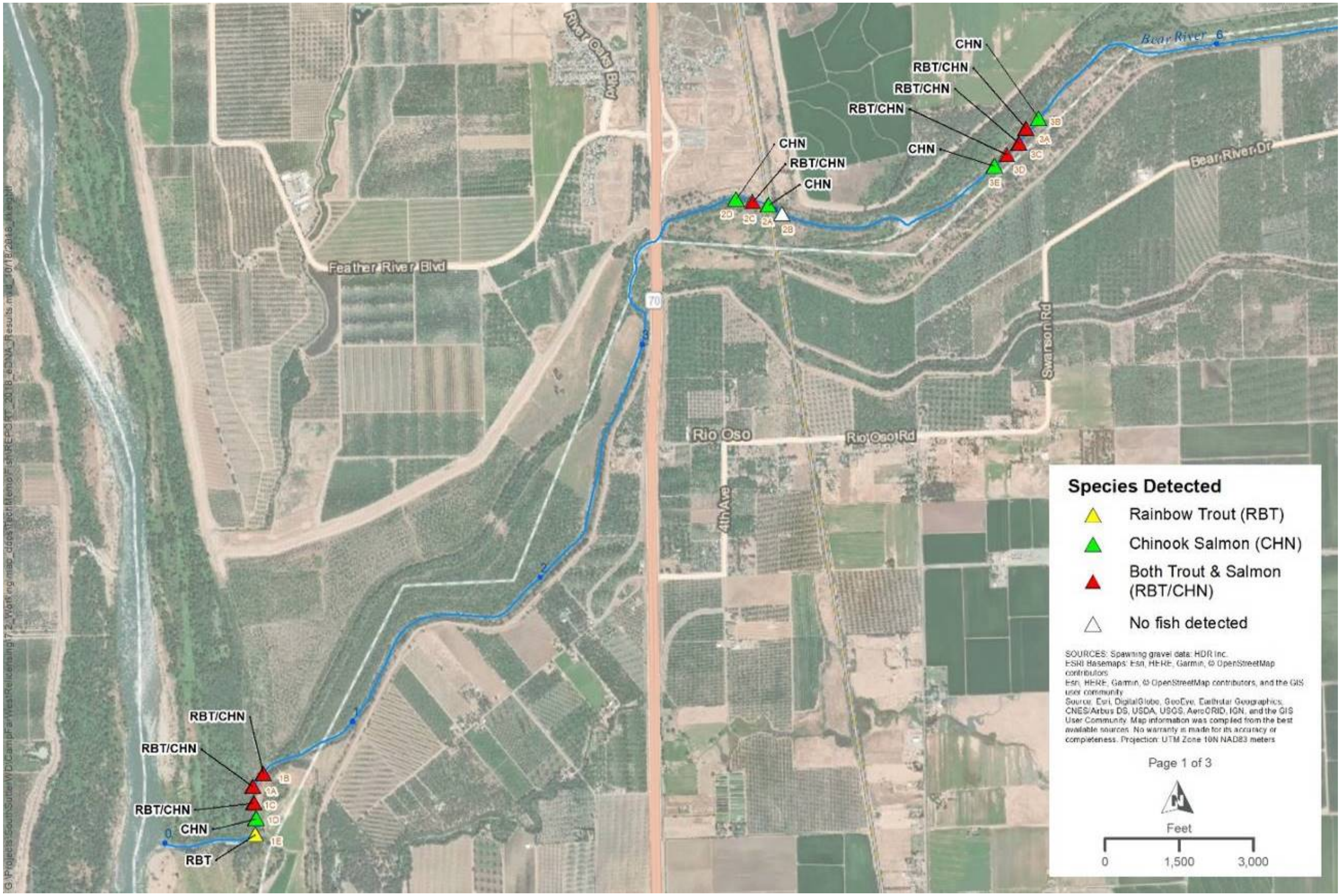


Figure 3.3.3-12. eDNA sampling locations and species detected (Reaches 4 and 5).

SSWD's Relicensing Salmonid Redd Surveys

Sporadic salmon surveys on the Bear River were documented from 1982 to 1986 by CDFG (CDFG unpublished data). Salmon numbers and redd observations depended on flows and water temperature. Salmon surveys by CDFG employees indicated the presences of roughly 100 adult salmon and steelhead strays in the Bear River in 1982. Salmon surveys were conducted from the non-Project diversion dam to Highway 70, occurred on November 16 and November 19, 1984. On November 16, 1984, CDFG employees reported seven salmon (four males and three females) were on redds and one additional unattended redd from the diversion dam to Patterson's Sand and Gravel plant (~RM 15). Also, On November 16, 1984, CDFG employees canoed from Highway 65 to Hudson Road and found five fresh carcasses (two male, two female and one jack), one carcass, six live fish and 15 redds. On November 19, 1984, CDFG employees canoed from Hudson Road to Highway 70. From Hudson Road to Pleasant Grove Road, CDFG reported finding one male carcass, one live female, and 35 redds. From Pleasant Grove Road to Highway 70, CDFG observed three skeletons (two male and one female), one pair of salmon spawning and six unattended redds. CDFG employees conducted salmon redd surveys in December of 1986 and observed only one male carcass.

SSWD conducted salmon redd surveys from October 17 through December 8, 2016. Redds were first documented on November 7, 2016 (Figure 3.3.3-13). Surveys ceased on December 8, 2016, due to high flows and low visibility (Figure 3.3.3-14). River conditions were monitored approximately every two weeks to determine if redd surveys could be resumed during the monitoring period. Secchi depths ranged from 0.2 to 0.6 m, which is less than the generally accepted minimum visibility for redd surveys of 1.2 m (PSMFC 2017). Flows ranged from 1,388 to 4,851 cfs during the periodic checks, causing visibility and safety concerns. The maximum flow during the potential survey period in the Bear River, measured at the Wheatland gage, was 34,900 cfs in January 2017. Due to these conditions, no further redd surveys were conducted during the remainder of the 2016/2017 period, which ended on March 31, 2017.

Figure 3.3.3-13. Typical Chinook salmon redd on the lower Bear River, photo taken during November 7, 2016 redd survey.

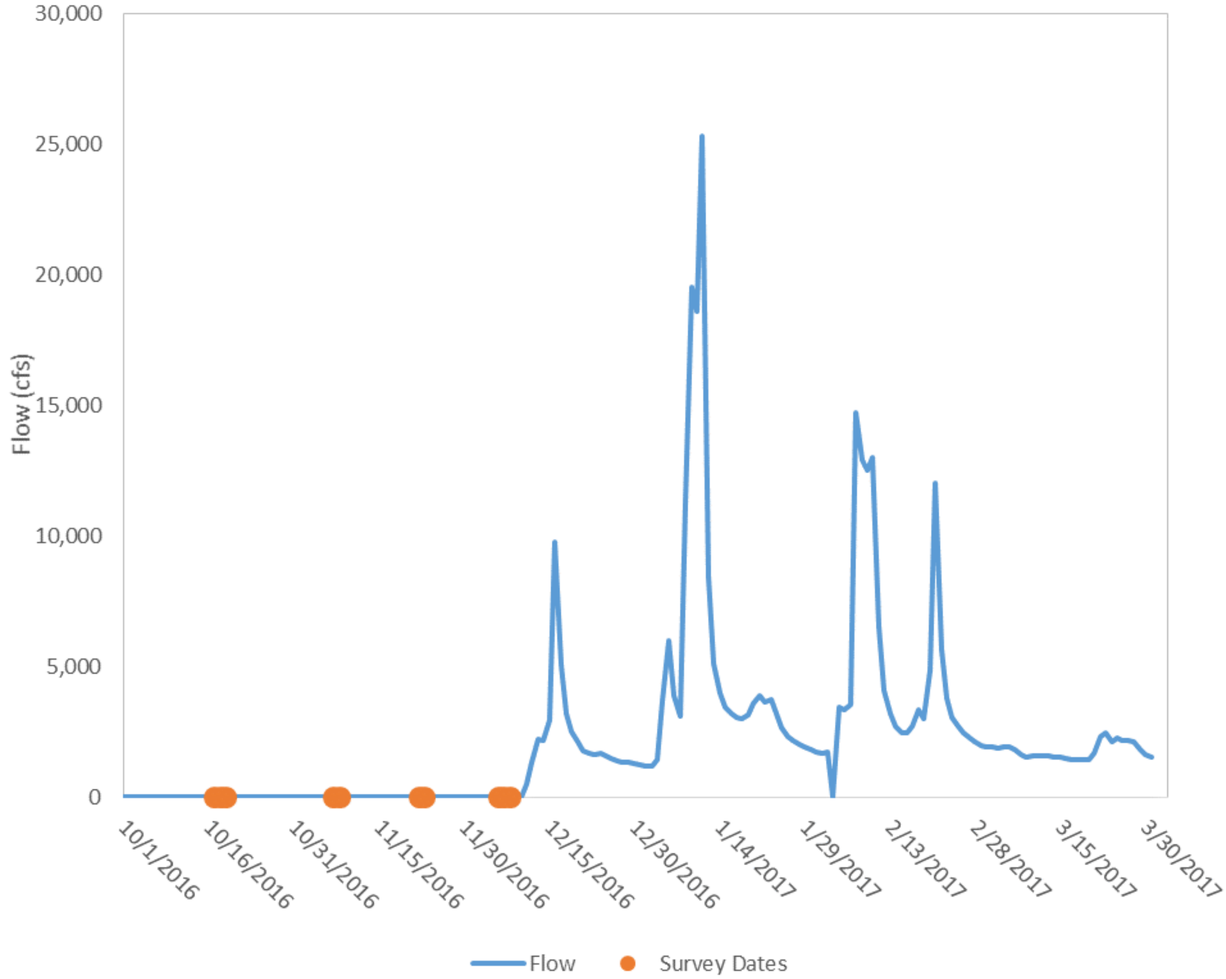


Figure 3.3.3-14. Discharge in the lower Bear River (measured at USGS Wheatland gage) during the 2016-17 redd survey season (October 1, 2016 through March 30, 2017).

The four surveys conducted in 2016 resulted in the documentation of 23 redds, four adult CV fall-run Chinook salmon ESU, and three Chinook salmon carcasses. Of the 23 redds documented in 2016, none were recorded in Reach 2; 20 in Reach 3; and 3 in Reach 4. No Chinook salmon were observed actively spawning. New redds were observed during surveys on November 7 and 8, November 22 and 23, and December 7 and 8, 2016. Estimated pot (i.e., the depression formed by the excavation of gravels by female salmon during redd construction), areas ranged from 0.29 to 8.75 square meters (sq m), and total redd area ranged from 1.27 to 36.73 sq m. Pot depths were not estimated because visual estimation of depth can be highly variable depending on water clarity, lighting conditions, and velocity.

SSWD conducted four additional salmon redd surveys between January and March 2018 to gather additional data on salmonid spawning. The first surveys were conducted from January 15 through 17, 2018, during a break in high winter flows (Figure 3.3.3-15). During this event, SSWD identified a total of 78 Chinook salmon redds, 10 adult Chinook salmon, and six Chinook salmon carcasses. Out of the 78 redds identified, 35 were found in Reach 2; 23 in Reach 3; and

20 in Reach 4 (Figures 3.3.3-16 through 3.3.3-20). Redd age was difficult to determine due to the late date of the spawning surveys, and the presence of periphyton that had begun to regrow on most redds. No new redds were identified in the later three redd surveys in 2018.

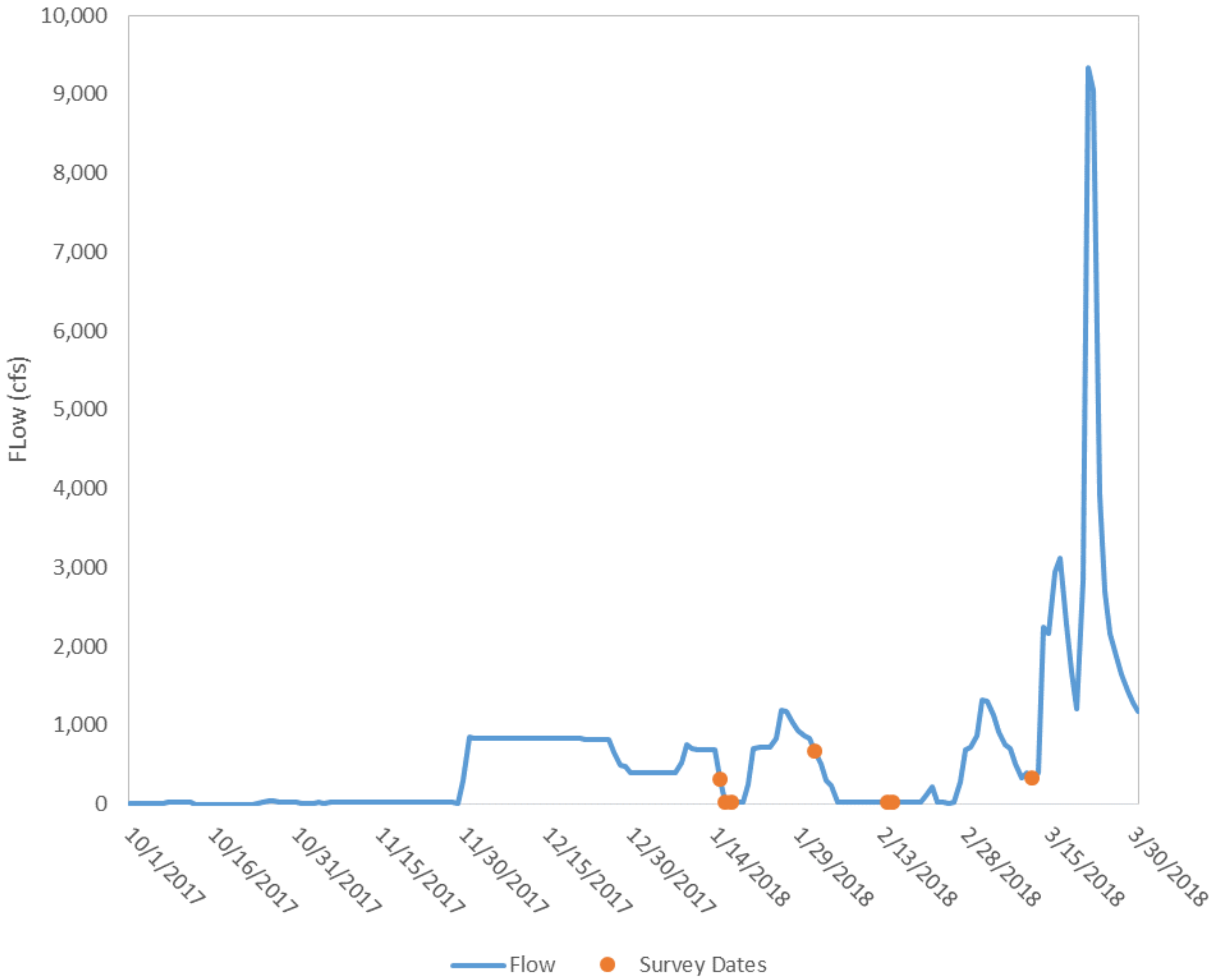


Figure 3.3.3-15. Discharge in the lower Bear River during the 2017-18 redd survey season (October 1, 2017 through March 30, 2018).

Redd area ranged from 0.36 to 39.26 sq m in 2018. Pot substrate was variable, ranging from sand to cobble, and tailspill substrate was typically one size class smaller than the associated pot substrate (Table 3.3.3-23).

Table 3.3.3-23. Minimum, maximum, and average values for redd area, pot depth and velocity, and substrate.

Range	Area (square meters)			Pot Depth (meters)	Pot Velocity (meters per second)	Substrate	
	Pot	Tail Spill	Total			Pot	Tailspill
Minimum[1]	0.22	0.13	0.36	0.1	0	sand	sand
Maximum[1]	13.37	29.64	39.26	0.6	0.7	cobble	cobble
Average[1]	2.77	4.84	7.61	0.3	0.2	cobble	coarse gravel

[1] n = 78.

Figure 3.3.3-16. Locations of redds observed during surveys in Reach 2 in 2016 and 2018.

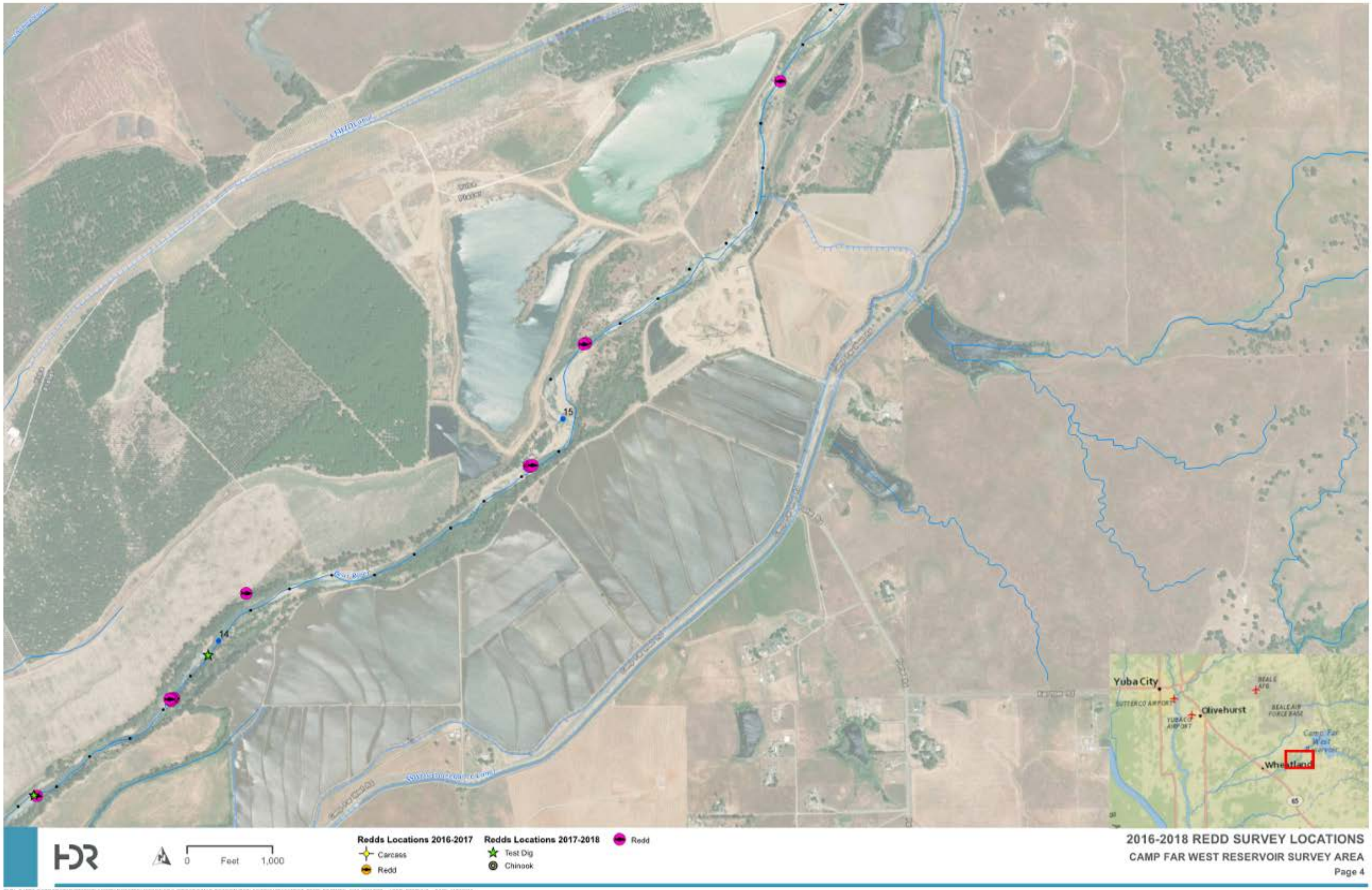


Figure 3.3.3-17. Locations of redds observed during surveys in Reach 2 in 2016 and 2018.

Figure 3.3.3-18. Locations of redds observed during surveys in Reaches 2 and 3 in 2016 and 2018.

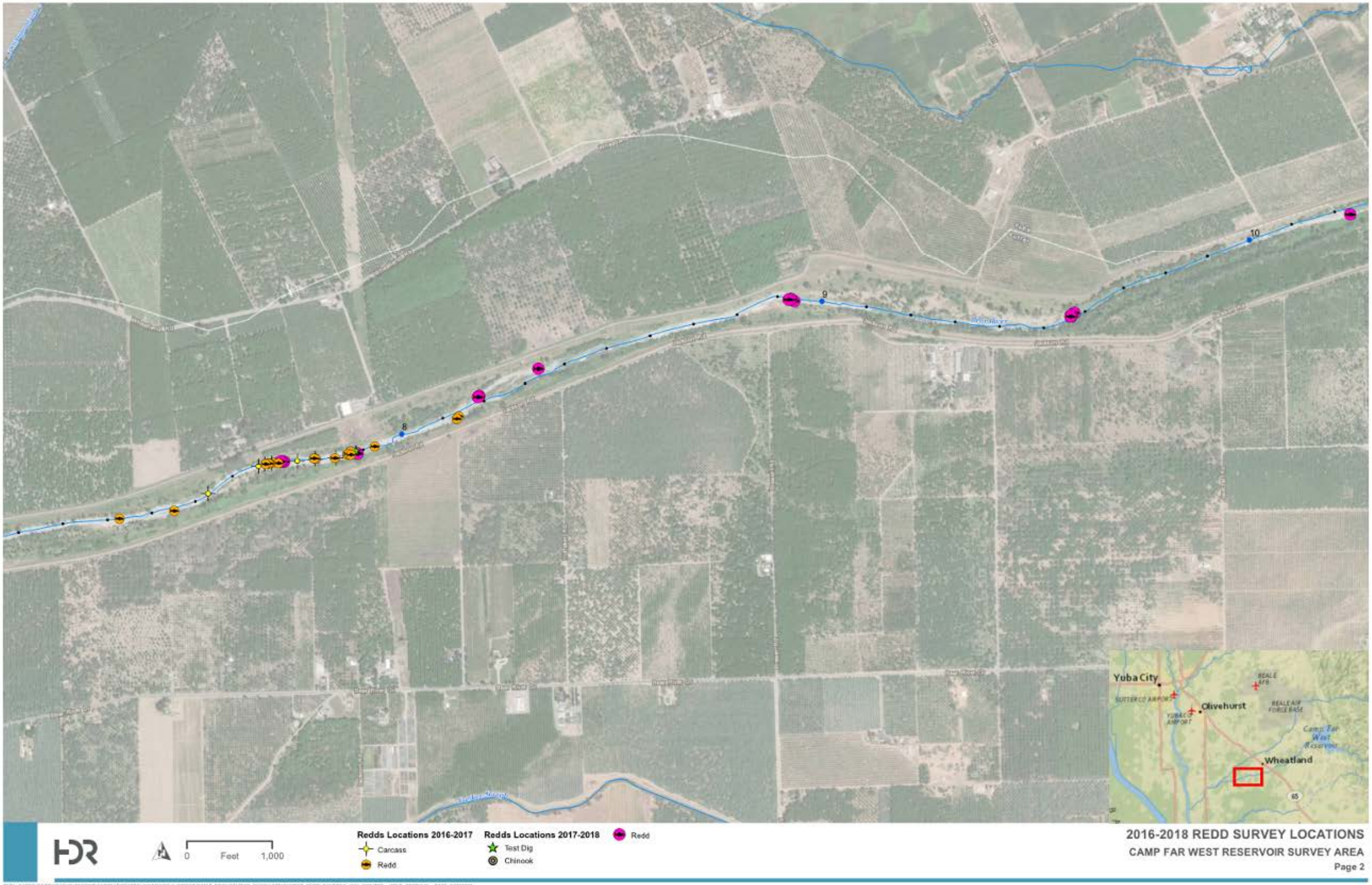


Figure 3.3.3-19. Locations of redds observed during surveys in Reach 3 in 2016 and 2018.

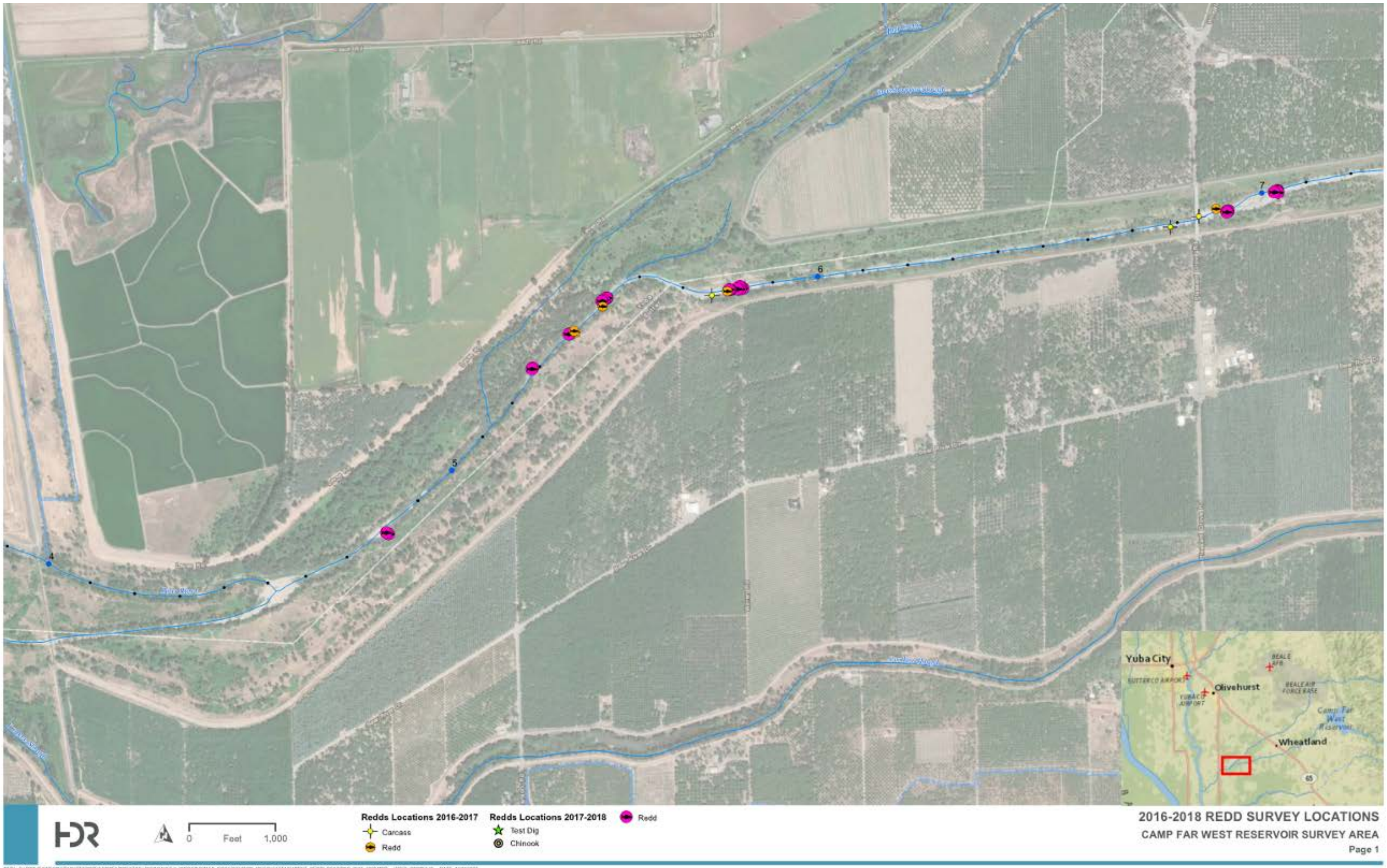


Figure 3.3.3-20. Locations of redds observed during surveys in Reach 4 in 2016 and 2018.

SSWD's Relicensing Salmonid Spawning Gravels Surveys

SSWD conducted a salmonid spawning gravel assessment survey of the lower Bear River in June 2018 as part of Study 3.2 and found that gravel conditions are suitable for anadromous salmonid spawning. Due to the extensive distribution of gravel in the D_{50} diameter of 0.11 to 5.9 in. (2.8-150 mm), a two-tiered classification system was devised to provide higher resolution to the study results. Areas that were identified in the Low Flow Active Channel (LFAC, i.e. the wetted channel) were classified as primary spawning gravel. These were areas that adult Chinook salmon could use to spawn under minimum flows requirements in the existing license. All other gravels falling within the D_{50} of 0.11 to 5.9 in. that were identified outside the LFAC, but within the bank full channel, were classified as secondary spawning gravel. Deep pools with little potential for use as spawning habitat were included in the surveys due to the systematic sampling design employed, but were accounted for separately in the calculations. Velocity transects and pebble counts were collected at areas of primary spawning gravel, but not secondary.

Representative areas surveyed at 250 m intervals showed that spawning gravels were present throughout the majority of the lower Bear River, with significant deposits in RMs 5 to 8 and 14. The primary concentration of gravel was within Reach 3 (RM 6.8-11.5), where the majority of spawning activity was noted between surveys in 2016 and 2018 (n=20 and 23, respectively). In primary habitats of surveyed areas (i.e. LFAC), suitable spawning gravels comprised an average of 24.1 percent of sampled non-pool habitats (i.e. riffle, run, or glide) by RM (minimum 0.0%, maximum 56.8%; Table 3.3.3-24), and an average of 6.9 percent of sampled pool habitats by river mile (minimum 0%, maximum 32.2%). Much of pool habitat is not considered spawning habitat due to depth, but the tailouts of pools offered suitable deposits. While deposits were concentrated in Reach 3, 9 of 16 RMs had deposits greater than 20 percent of the sampled area, offering a broad spatial range for spawning opportunities. In secondary habitats that were surveyed (i.e. outside of the wetted channel, but within bank full width), spawning gravels comprised an average of 26.8 percent of sampled habitats by river mile (minimum 0%, maximum 70.5%). Reach 4 had the highest individual maximum deposit of surveyed areas, but Reach 3 again had the greatest average overall.

Where spawning gravels were present in primary habitats, pebble counts were conducted. The average median particle size, or D_{50}, was approximately 0.98 in. (25 mm, Figure 3.3.3-21), a value that corresponds with coarse gravels. The range of D_{50} particle sizes that is commonly accepted to comprise suitable spawning gravels for Chinook salmon and steelhead is 0.11 to 5.9 in.; all but one sample site had D_{50} values within that range. The one site that had a D_{50} value of approximately 0.06 in. (1.6mm) had a subdominant substrate component of silt/clay. Velocities were also measured where primary spawning gravels were identified. Velocities ranged from 0.03 ft/s to 5.48 ft/s, and the average median velocity (averaged across all sites) was 1.86 ft/s (Figure 3.3.3-23).

Table 3.3.3-24. Spawning gravel availability for primary (i.e. within the low-flow active channel) and secondary habitats that were surveyed, presented as the average percent of available habitat comprised by spawning gravels and shown by river mile. Primary habitats are further partitioned into non-pool (i.e. riffle/run/glide) and pool habitats.

General Reach Boundary	River Mile	Average Percent of Primary Spawning		Proportion of Non-Pool Habitats (%)	Average Percent of Secondary Spawning Gravels (%)
		Non-Pool Habitats (Riffle/Run/Glide)	Pool Habitats		
4	3	5.0	0.0	0.33	12.0
	4	16.2	8.9	0.25	27.1
	5	32.8	6.7	0.33	32.4
	6	30.0	0.0	0.25	0.0
3	7	56.8	20.4	0.57	62.1
	8	49.0	32.2	0.71	48.4
	9	20.0	0.9	0.14	45.7
	10	20.7	1.7	0.43	26.5
	11	21.6	12.2	0.50	23.0
2	12	26.9	8.2	0.43	70.5
	13	19.4	3.1	0.29	19.0
	14	32.5	2.1	0.57	8.6
	15	0.0	0.7	0.17	0.0
	16	7.0	0.0	0.57	0.3
	Average	**24.1**	**6.9**	**0.40**	**26.8**

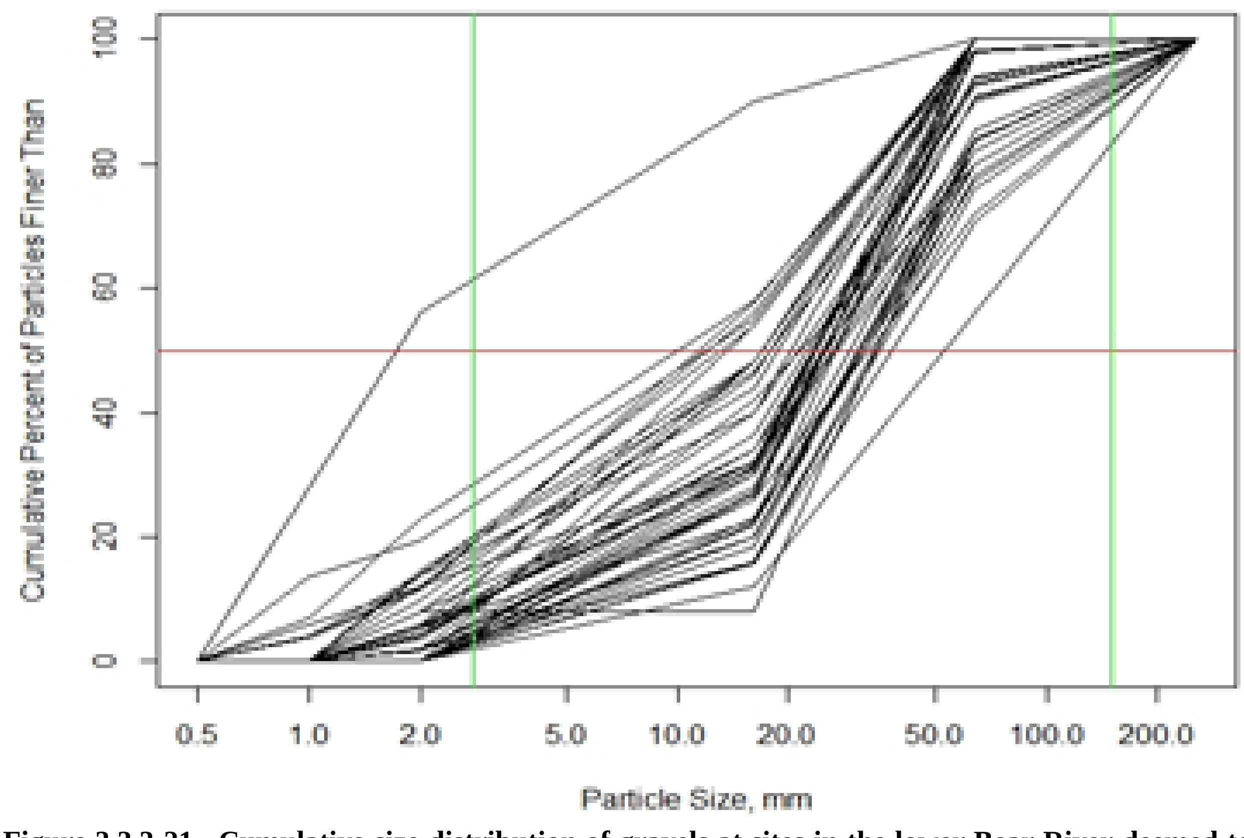


Figure 3.3.3-21. Cumulative size distribution of gravels at sites in the lower Bear River deemed to be suitable for salmonid spawning. Each black line represents a distribution of substrate sizes at a single site. The horizontal red line indicates the location of the 50th percentile of particle diameters, or D50 value. The vertical green lines indicate the lower and upper threshold diameters of gravel particle sizes that are commonly deemed suitable for salmonid spawning (0.11-5.9 in., or 2.8-150 mm).

SSWD's Relicensing Instream Flow Study for Target Species

CDFG (1991) found that fall flows in the lower Bear River are not usually high enough to attract salmon to migrate up and spawn. During years where the October and November flows are high, CDFG estimated adult spawning runs as high as 300 fish (Table 3.3.3-2). Based on the evaluation of Chinook salmon life stage periodicities and analysis of WUA/streamflow indices, CDFG developed a set of instream flow recommendations. In 1991, CDFG recommended the following flows in the lower Bear River, as measured at the Wheatland gage (Gage 11424000) to optimize CV fall-run Chinook salmon ESU habitat:

- 100 cfs from October 1 to 14 to provide ample depth and attraction for upstream adult migration and early spawning of fall-run Chinook salmon
- 250 cfs from October 15 to December 31 to provide maximum spawning habitat for fall-run Chinook salmon, when the majority of spawning occurs
- 190 cfs from January through March to prevent dewatering of fall-run Chinook salmon redds, alevins, and/or stranding of fry
- 100 cfs from April through June to provide maximum fall-run Chinook salmon juvenile salmon rearing habitat and facilitate their downstream movement
- 10 cfs from July through September for fall-run Chinook salmon juveniles' migration to the ocean by June

CDFG noted that its recommended flows may provide habitat and water temperatures favorable to CV fall-run Chinook salmon ESU, but would likely not meet the requirements for steelhead. CDFG also acknowledged that water diversions and operations upstream of Camp Far West Reservoir may limit the ability to deliver the recommended flows and subsequent improvements to habitat and water temperature. Recommendations for future studies included increased upstream analysis, steelhead-specific studies, and consideration of dry year criteria. CDFG's flow recommendations were not implemented.

Jones & Stokes (2005) stated that the Bear River historically experienced high winter flows and low summer flows, but present-day flow timing and volume is highly regulated by storage reservoir releases and diversions. The exportation of water diverted from the Bear River watershed is made through the conveyance facilities of NID and PG&E. The flow is diverted for irrigation, power generation, and domestic supply uses in the Auburn area. The report stated that upstream diversions from the Bear River basin have depleted the streamflow downstream of the non-Project diversion dam. Jones and Stokes stated that minimum flow releases are 25 cfs in the spring and 10 cfs during the rest of the year and that flows in the Bear River below the diversion dam range between zero and 40 cfs from June to December. Its report found that current winter flows during wet years are similar to unimpeded flows, averaging 2,500 to 5,200 cfs, and that summer flows are currently 30 to 50 percent less than the unimpaired flows.

During a water transfer in 2018, SSWD recorded velocities in the Bear and Feather rivers using an acoustic Doppler current profiler (ADCP). During this period, flows in the Feather River ranged from approximately 2,500 to 6,000 cfs measured at Star Bend (CDEC – FSB) during the transfer and the Bear River flows ranged from approximately 125 to 150 cfs measured at

Pleasant Grove (CDEC – BPG) (Figure 3.3.3-22). On average, flows in the Feather River were 20 to 50 times greater than in the Bear River. The higher flows in the Feather River resulted in a reduction to the velocity signature of Bear River flows at the confluence, as indicated by velocity measurements recorded by SSWD. Velocities in the Feather River at the confluence ranged from approximately 1.5 to 4 fps, while in the Bear River at the confluence, velocities ranged from approximately 0 to 0.8 fps (Figure 3.3.3-23). This demonstrates a backwatering effect of the Feather River up the Bear River, which was found to extend approximately 1 mi upstream of the confluence, and denotes a lack of attraction flow from the Bear River even when Bear River flows are greater than the existing minimum instream flows during the summer months.

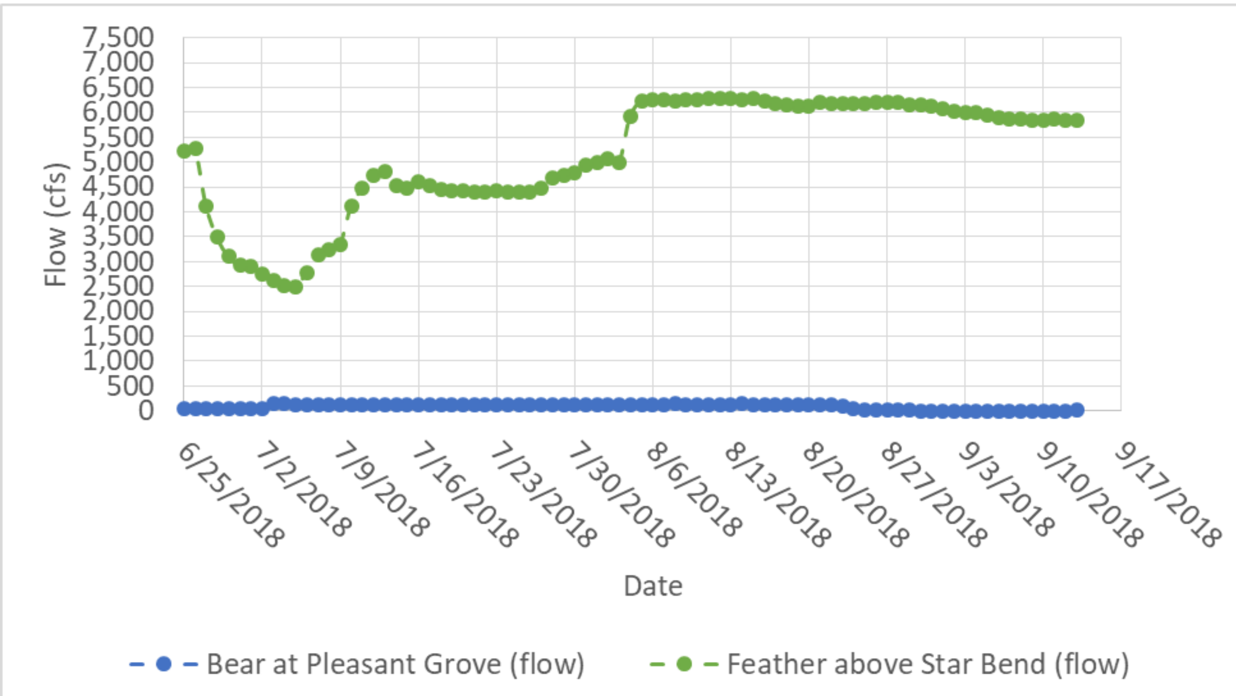


Figure 3.3.3-22. Flows in the Bear and Feather Rivers during the 2018 SSWD water transfer.

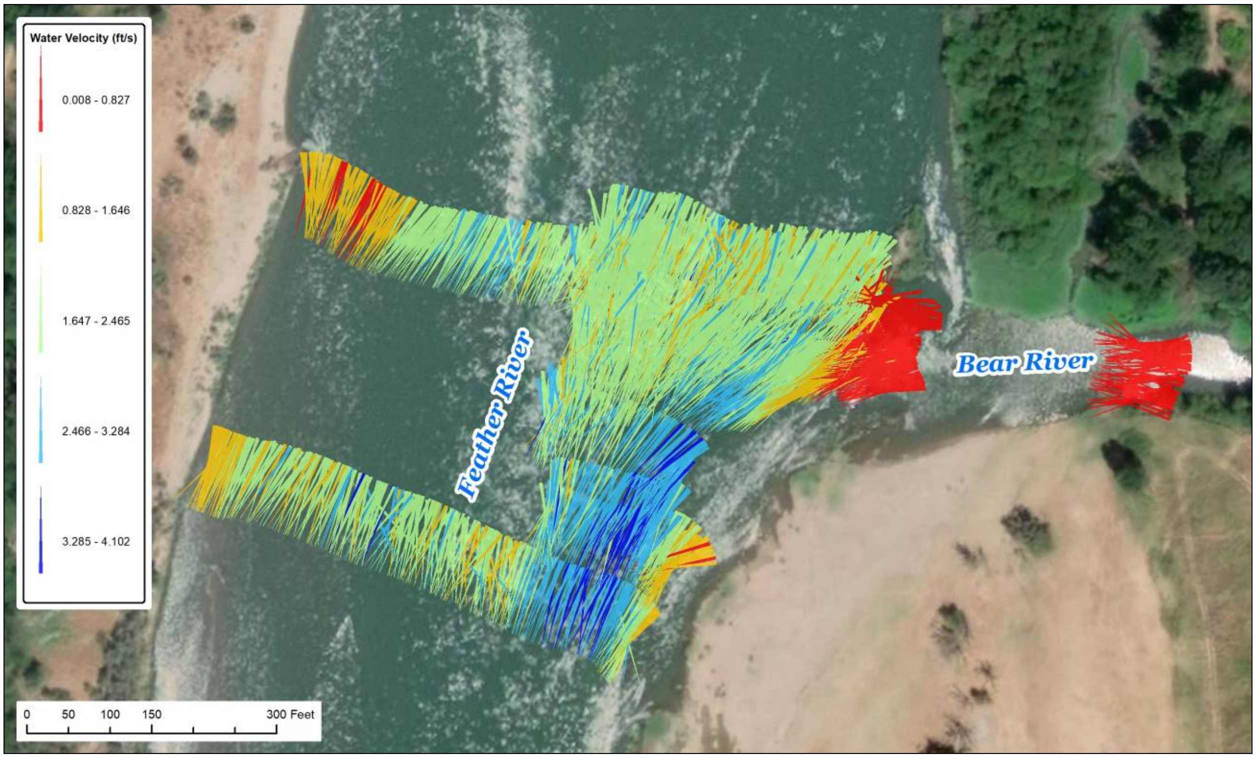


Figure 3.3.3-23. Measured velocities at the confluence of the Bear and Feather rivers during the 2018 SSWD water transfer. Red indicated little to no velocity and green and blue represents higher velocities.

SSWD performed an Instream Flow Study using River 2D (i.e., 2 dimensional) habitat modeling to simulate the relationship for stream flows to fish habitat suitability – defined by water depth and velocity, and substrate availability – at two study sites downstream of the non-Project diversion dam at locations where fish spawning and breading are known to occur. The two sites, named 'Upstream' and 'Downstream' in the relicensing Instream Flow Study, were selected in collaboration with Relicensing Participants in August 2017. Habitat types and lengths from habitat mapping completed in 2017 were used to assess reach-wide habitat composition to habitat composition within each site. One site was in Reach 2 and extended from RM 14.2 to RM 15.05. The second site was located in the Reach 3 and extended from approximately RM 7.7 to RM 8.3. (Figure 3.3.3-24.) SSWD collected topographic data at both sites from levee to levee. A comparison of reach habitat frequency and study site habitat frequencies is provided in Table 3.3.3-25.

Figure 3.3.3-24. Location of instream flow 2-D sampling sites.

Table 3.3.3-25. Reach wide and Instream Flow Study site habitat frequency.

Unit Type	Length Frequency	Number of Units	Number of Units Frequency	Unit Length Frequency	Number of Units Frequency
UPSTREAM SITE (REACH 2)					
Glide	11.6%	6	7.7%	29.6%	12.5%
Lateral Pool	32.9%	18	23.1%	35.4%	37.5%
Low Gradient Riffle	7.1%	26	33.3%	10.4%	37.5%
Mid-channel Pool	45.4%	20	25.6%	24.6%	12.5%
Run	1.1%	5	6.4%	0.0%	0.0%
Totals[1]	**98.1%**	**75**	**96.2%**	**100.0%**	**100.0%**
DOWNSTREAM SITE (REACH 3)					
Glide	17.4%	12	19.0%	35.4%	28.6%
Lateral Pool	10.9%	12	19.0%	12.3%	14.3%
Low Gradient Riffle	8.3%	17	27.0%	13.6%	35.7%
Mid-channel Pool	32.0%	14	22.2%	36.3%	14.3%
Run	4.4%	4	6.3%	2.4%	7.1%
Trench Pool	24.4%	2	3.2%	0.0%	0.0%
Totals[2]	**97.5%**	**61**	**96.8%**	**100.0%**	**100.0%**

[1] Reach 2 frequencies do not include one 144 foot plunge pool and two split channels totaling 400 ft.
[2] Reach 3 frequencies do not include two split channels totaling 511 ft.

A third site was selected by USFWS in Reach 4 and was surveyed and modeled by USFWS in 2017 and 2018 independently of the SSWD data collection and modeling efforts. The USFWS Site maintained habitat frequencies similar to reach-wide composition and extended from approximately RM 4.2 to RM 4.8 (Figure 3.3.3-24). Results from the USFWS modeling effort are provided as a supplement to results generated by SSWD models. Specific details on the USFWS effort are provided where available.

SSWD collected the majority of field data, including topographic data and hydraulic calibration measurements between October 2017 and February 2018. Additional hydraulic calibration measurements were collected in July 2018 near the target calibration flow of 100 cfs. A summary of flows and calibration data obtained at the study sites is provided in Table 3.3.3-26. At the Upstream Site a total of 52,455 topographic data points were collected. At the Downstream Site a total of 27,083 topographic data points were collected.

Table 3.3.3-26. Calibration data collection summary for SSWD Instream Flow Study sites.

Location	Date	Measured Discharge (cfs)[1]	Wheatland Gage (cfs)[2]	Obtained Calibration Criteria[3]
Upstream Study Site	12/14/17	674.1	827	Boundary conditions
	01/19/18	17.0	23	Boundary conditions and 46 calibration nodes
	02/20/18	15.9	16.9	Boundary Conditions
	02/21/18	332.9	300	Boundary conditions and 21 calibration nodes
	07/19/18	127.2	120	Boundary conditions and 50 calibration nodes

Table 3.3.3-26. (continued)

Location	Date	Measured Discharge (cfs)[1]	Wheatland Gage (cfs)[2]	Obtained Calibration Criteria[3]
Downstream Study Site	12/14/17	734.5	827	Boundary Conditions
	01/18/18	15.6	22.3	Boundary conditions and 49 calibration nodes
	02/19/18	12.9	17.5	Boundary Conditions
	02/22/18	319.7	300	Boundary conditions and 49 calibration nodes
	07/18/18	125.0	116	Boundary conditions and 52 calibration nodes

[1] Measured discharges above 200 cfs are an average of three or more individual discharge measurements utilizing an ADCP. Measured discharges below 200 cfs were measured manually utilizing a recently calibrated Swoffer current velocity meter and USGS top setting wading rod.

[2] Wheatland gage flows are approximate and showed minor variation from the values.

[3] Boundary conditions include water surface elevations at the upstream and downstream model boundaries. Calibration nodes are random and discrete locations within each modeling site where water surface, depth and mean column velocity were measured.

In addition to field data collection for hydraulic and habitat model development, four level loggers were installed to measure stage change in the Bear River downstream of the non-Project diversion dam in November of 2017. Level loggers were installed immediately upstream of the modeling site in Reach 2, approximately 1,000 ft downstream of the Highway 65 bridge, approximately 1,200 ft upstream of the Pleasant Grove Road bridge, and 2,000 ft downstream of the Highway 70 bridge. Loggers at all locations were recovered unfixed from their original deployment location after high flows in December 2017 and were redeployed in January 2018. Complete stage information for a full calendar year is not yet available.

Topographic data for the Upstream and Downstream sites were post processed and verified in Trimble Business Center and Microsoft™ Excel to ensure that there were no obvious elevation errors in the survey data. Once initial quality control measures were completed, topographic data were entered into ArcGIS for the development of a Triangulated Irregular Network (TIN). The TIN was then imported to ArcScene for a visual verification of the topographic data. After visual verification field collected topographic data were integrated with publically available LiDAR data to fully characterize channel topography from Levee to levee.

Hydraulic modeling for each study site was completed using River2D (Steffler and Balckburn 2002). Verified and reviewed channel topography was further assessed in River2D Bed to look for areas with data gaps and bed files were modified in some locations to produce bed contours and channel features more representative of observed conditions. Most modifications were made in areas where dense vegetation, overhead canopy cover, or terrain characteristics made field collection of accurate topography data difficult.

Once bed files were completed, a computational mesh for each study site was developed. Mesh development followed procedures outlined in the River2D mesh User manual, 2002 (Waddle and Steffler 2002). Each mesh was developed in four steps: uniform fill at 5.0 meters, wet refine at 1,500 cfs, region refinement, quality index (QI) improvement. Region refinement is the most intensive step in mesh development and reconciled high elevation differences remaining between the bed file and the mesh after the two preceding steps. The River 2D Mesh program pinpoints mesh triangles with elevation differences exceeding a specified threshold by highlighting them yellow. Region refinement was completed by further densifying the mesh in locations with yellow triangles with the elevation threshold set to 0.2 meters. Region refinement was considered complete when yellow triangles were eliminated or where the resulting size would have limited to no effect on model results. Comparison of mesh generated contours to bed file contours at 0.2 meter intervals was performed concurrently with yellow triangle reduction and elimination as part of the region refinement step. During each step in mesh development the QI is monitored. After completion of region refinement small changes were made to specific mesh node locations throughout each mesh to improve QI. One base mesh for each study site was used for all simulation runs, representing the model domain. Minor changes to the mesh were made in each simulation to improve model run time errors and improve model characterization at especially low flows. A summary of mesh metrics for the Upstream and Downstream Sites is provided in Table 3.3.3-27. Mesh metrics from the USFWS Site are also provided in Table 3.3.3-27 but the development process may have varied slightly from that used for the two SSWD sites.

Table 3.3.3-27. Mesh development metrics for SSWD and USFWS sites.

Location	Mesh Nodes	Mesh Elements	Quality Index (QI)
Upstream Site	32,294	64,546	0.349
Downstream Site	32,316	64,610	0.382
USFWS Site	35,146	70,258	0.299

For each hydraulic model, initial hydraulic calibration tests were conducted using the surveyed calibration data collected at each modeling site, summarized in Table 3.3.3-27. Hydraulic calibration data measured in January and February 2018 were the primary datasets used for calibration. The data measured in July 2018 were not used given the hydraulic control changes measured at each site after flows of in excess of 14,000 cfs in March 2018. Six iterations of bed roughness (Ks) modifications were made to match WSEs measured in the field. WSE, velocity and depth model predictions were compared to measured field data to evaluate the effects of changes made to channel roughness. A summary of the absolute mean error between modeled and measured WSE, depth and velocity for the final selected bed roughness values at the Upstream and Downstream sites is provided in Table 3.3.3-28. Examples of final model files, including topographic contours and water depth at 25 cfs are presented in Figures 3.3.3-25 through Figure 3.3.3-27.

Table 3.3.3-28. Summary of absolute mean error for final bed files.

Location	Calibration Type	Discharge (cfs)	Calibration Nodes	Absolute Mean Error (ft)		
				Water Surface Elevation (ft)	Velocity (ft/sec)	Depth (ft)
Upstream Site	High Flow	332.9	21	0.074	0.394	0.330
	Low Flow	17.0	46	0.061	0.217	0.204
Downstream Site	High Flow	319.7	49	0.089	0.413	0.164
	Low Flow	15.6	49	0.034	0.158	0.204

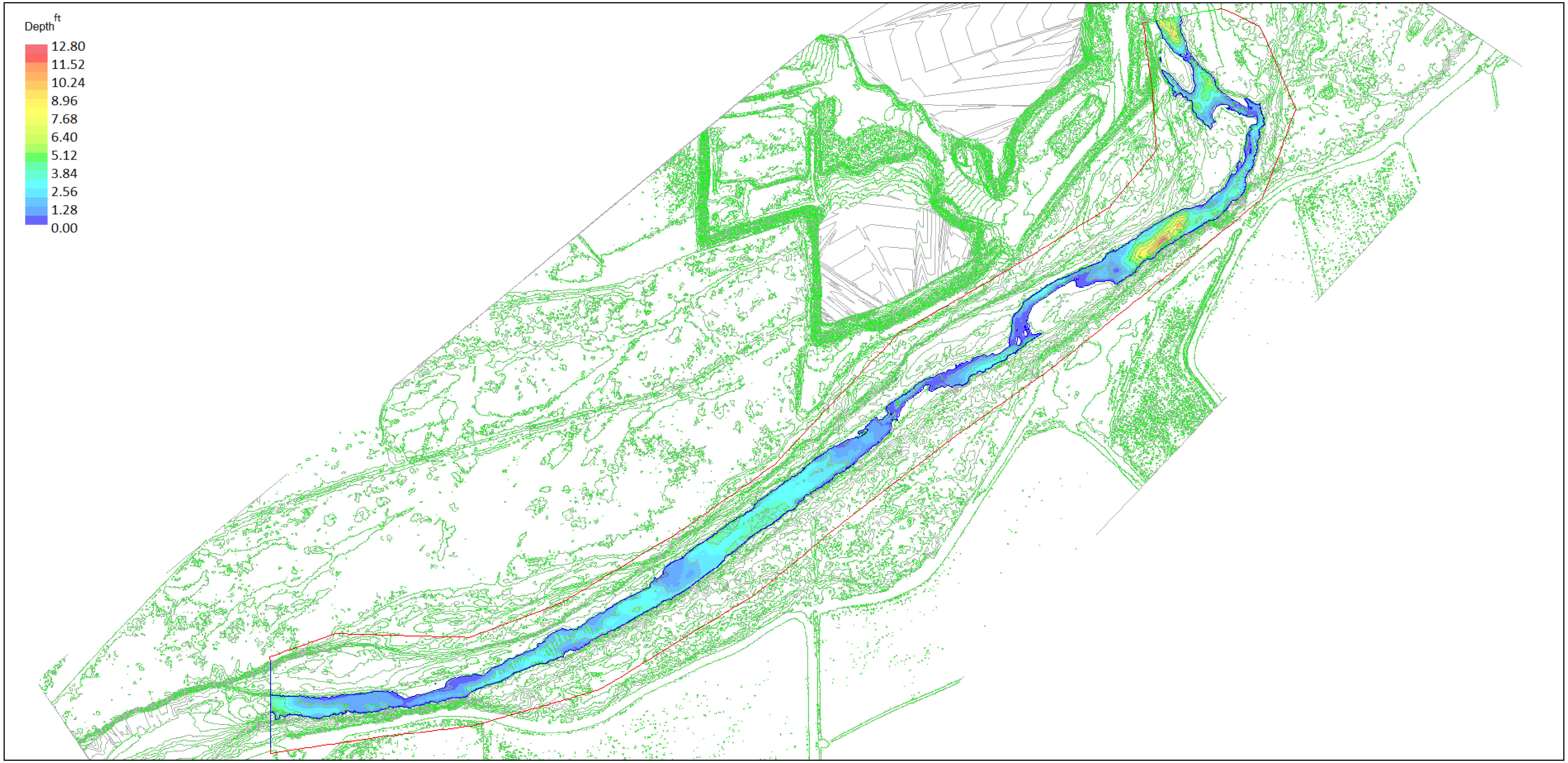


Figure 3.3.3-25. SSWD Upstream Site topographic contours and depth at 25 cfs.

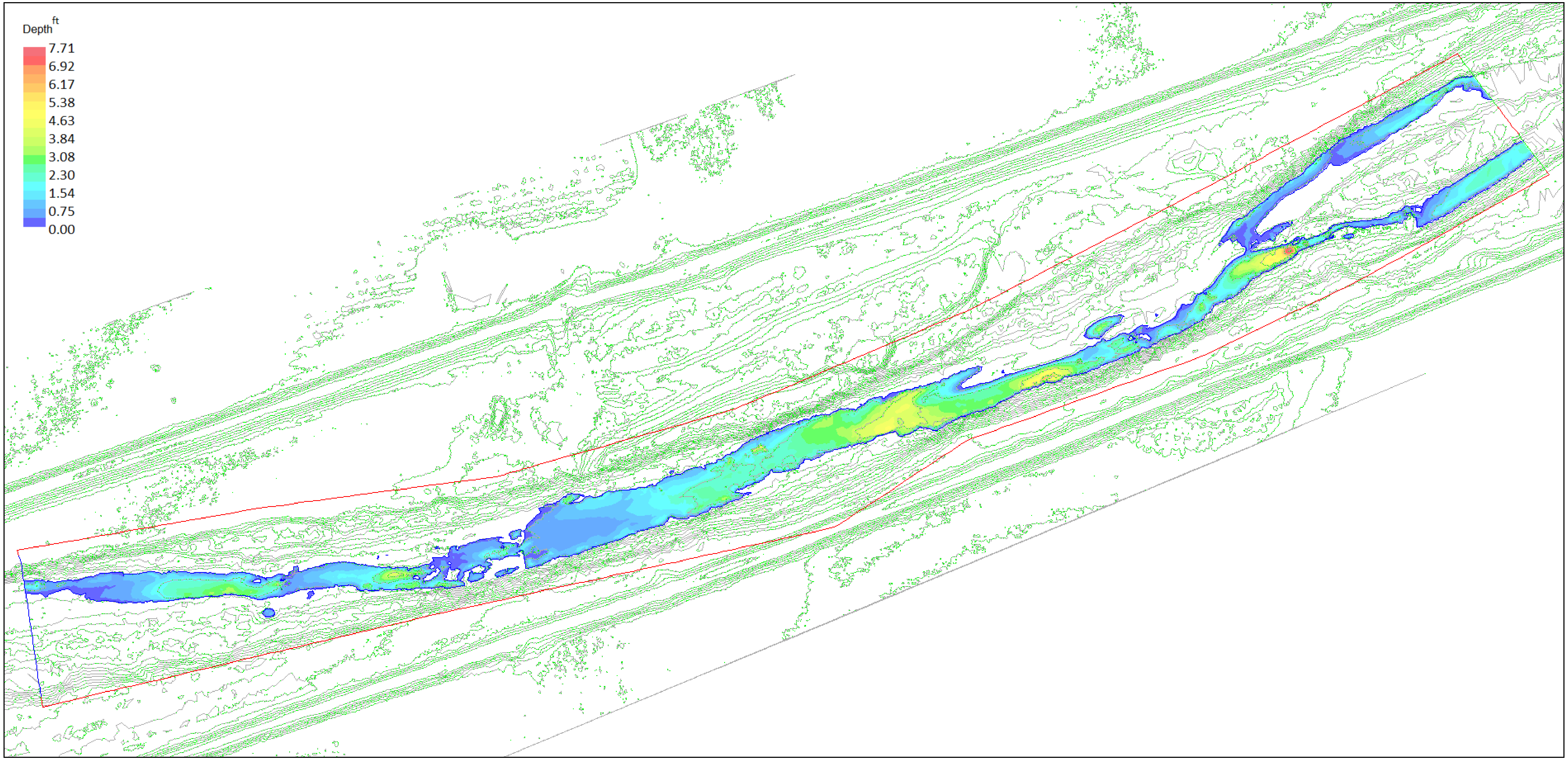


Figure 3.3.3-26. SSWD Downstream Site topographic contours and depth at 25 cfs.

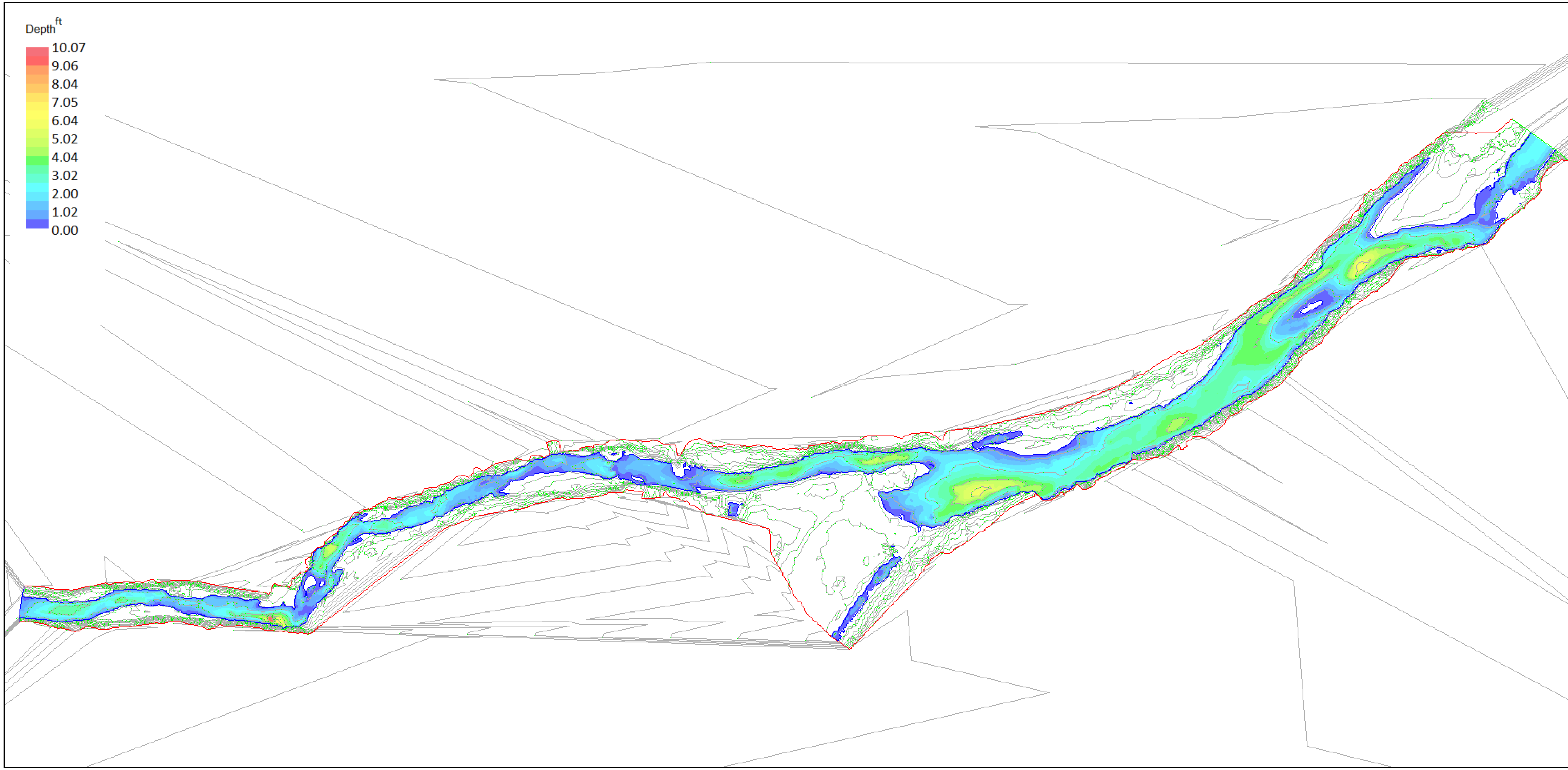


Figure 3.3.3-27. USFWS Site topographic contours and depth at 25 cfs.

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Rating curves provide initial model stage and discharge conditions for a range of modeled flow simulations and are used as model boundary conditions. Rating curves for each study site were developed using field measurements collected during each calibration field effort. Final rating curves for the Upstream and Downstream sites are provided in Attachment E3.3.3A.

Target fish species and habitat suitability criteria (HSC) were selected through a collaborative process with Relicensing Participants. Study target species and life stages were confirmed in the collaborative process and include Chinook Salmon spawning, fry, and juvenile; steelhead spawning, fry, and juvenile; sturgeon spawning; and hardhead adult and juvenile rearing. Final HSC and a description of the HSC selection procedure are provided in Attachment 3.3.3B.

A total of 18 discharges were simulated at each of SSWD's study sites. Simulation flows ranged from 10 cfs, the lowest minimum instream flow requirement for the lower Bear River, to 700 cfs, the typical maximum operational release from Camp Far West Reservoir (Table 3.3.3-29). At a flow of 700 cfs, the inundation level equates to areas of 363,344 sq ft, 332,235 sq ft and 271,037 sq ft for the Upstream, Downstream and USFWS sites, respectively. A tapered step-up approach was used for selection of specific simulations flows, with small increases between low flows from 10 cfs to 100 cfs, and graduated larger changes between higher flows (150 cfs to 700 cfs).

Table 3.3.3-29. Simulation discharges run for SSWD and USFWS models.

Simulation Discharge (cfs)	Simulation Description
10	Minimum Flow Requirement from July through March
15	Simulation only
20	Simulation only
25	Minimum Flow Requirement from April through June
30	Simulation only
35	Simulation only
40	Simulation only
50	Simulation only
75	Simulation only
100	Simulation only
125	Simulation only
150	Simulation only
175	Simulation only
200	Simulation only
250	Simulation only
300	Simulation only
450	Simulation only
700	Operational Capacity of Camp Far West Dam

Habitat suitability and weighted usable area (WUA), for all target species and life stages was calculated at each simulation flow. WUA is the product of a composite habitat suitability index at every node in the model domain and the area associated with each node. Four data inputs are required to calculate habitat suitability: a preference file, a channel index, depth, and velocity. Preference files were created from the final target species and life stage HSC. Two channel index files were developed for each study site: a substrate channel index for spawning life stages, and a cover channel index for salmonid fry and juvenile rearing life stages. Hardhead juvenile and adult HSC only include preferences for depth and velocity and no channel index file was used in these WUA calculations. To improve efficiency through revisions and production of maps and assessment tools, final WUA was calculated using a modeling tool developed in the Python programming language. A subset of River 2D output WUA calculations were compared to calculations from the tool. Resulting differences from this comparison were generally less than 3 percent.

Several open source libraries were used to develop the tool, namely 'numpy', 'scipy', 'pandas', and 'pyqtgraph'. 'Scipy' (scientific python) is used to interpolate the irregular triangulated mesh output from River2D into regularly spaced gridded data. Each grid cell throughout the model domain is 0.25 m^2. 'Numpy' (numerical python) is used to perform arithmetic operations on the gridded data, such as interpolation of depth and velocity, application of the suitability curves, and multiplication of the gridded data.

Modeling results from Upstream and Downstream Sites developed by SSWD, and results from the USFWS Site generated a total of 486 distinct WUA calculations. The results are driven by the geomorphic character of each study site and the specific species requirements described by the HSC information. Figures 3.3.3-28 through 3.3.3-36 provide the amount of WUA at each site for each target species life stage. Detailed data are provided in in Attachment 3.3.3C.

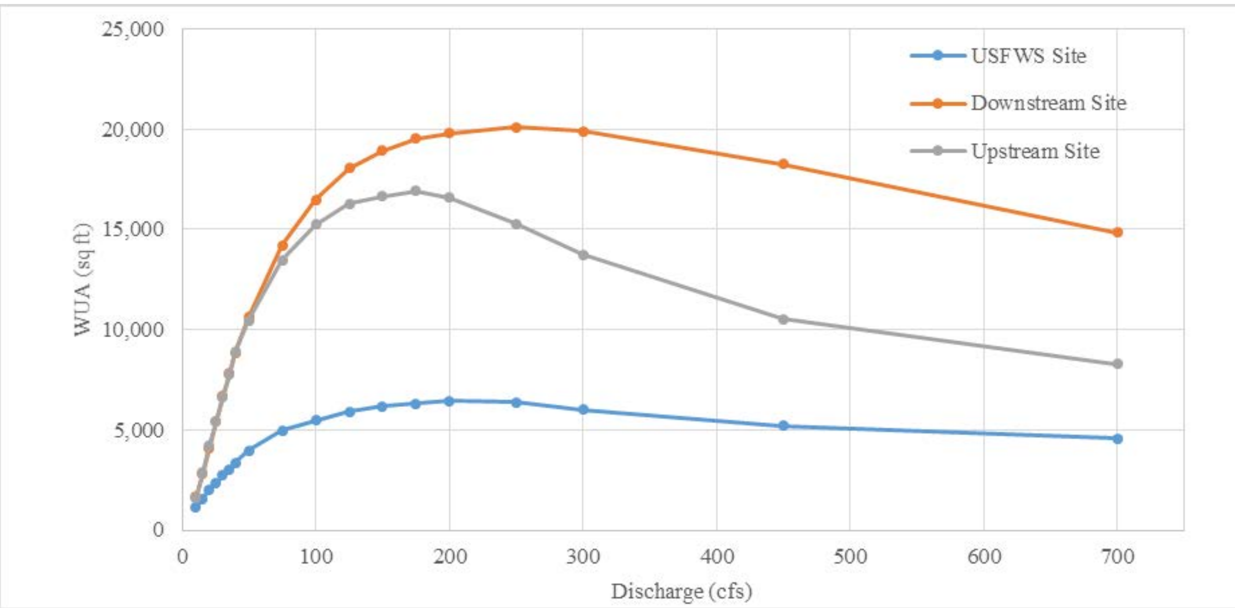

Figure 3.3.3-28. Chinook salmon spawning WUA at SSWD and USFWS sites.

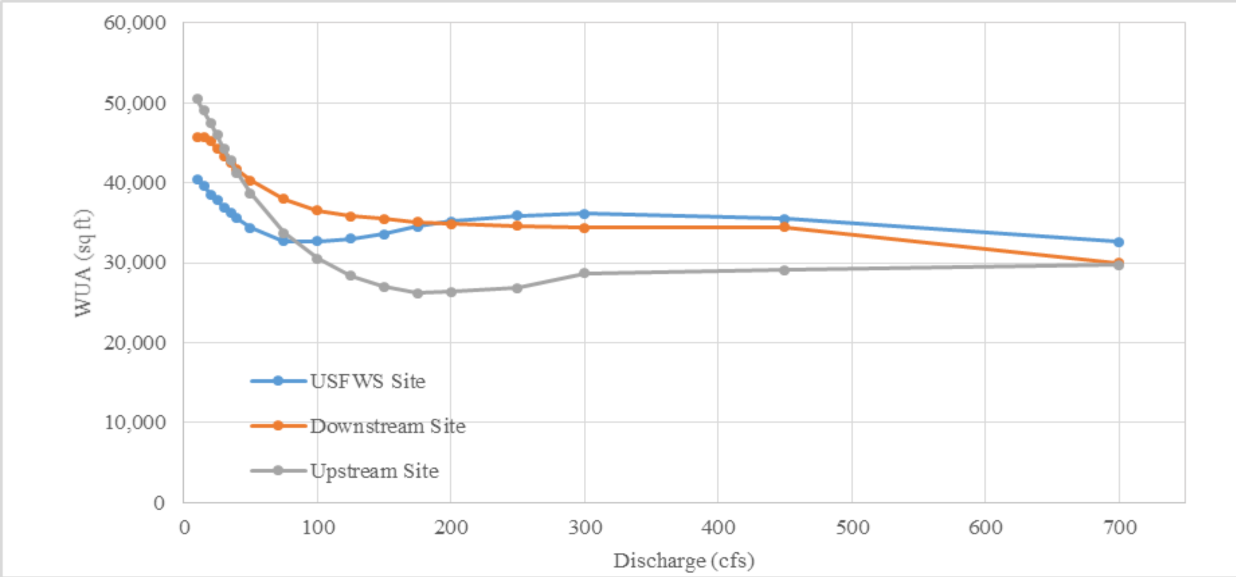

Figure 3.3.3-29. Chinook salmon fry rearing WUA at SSWD and USFWS sites.

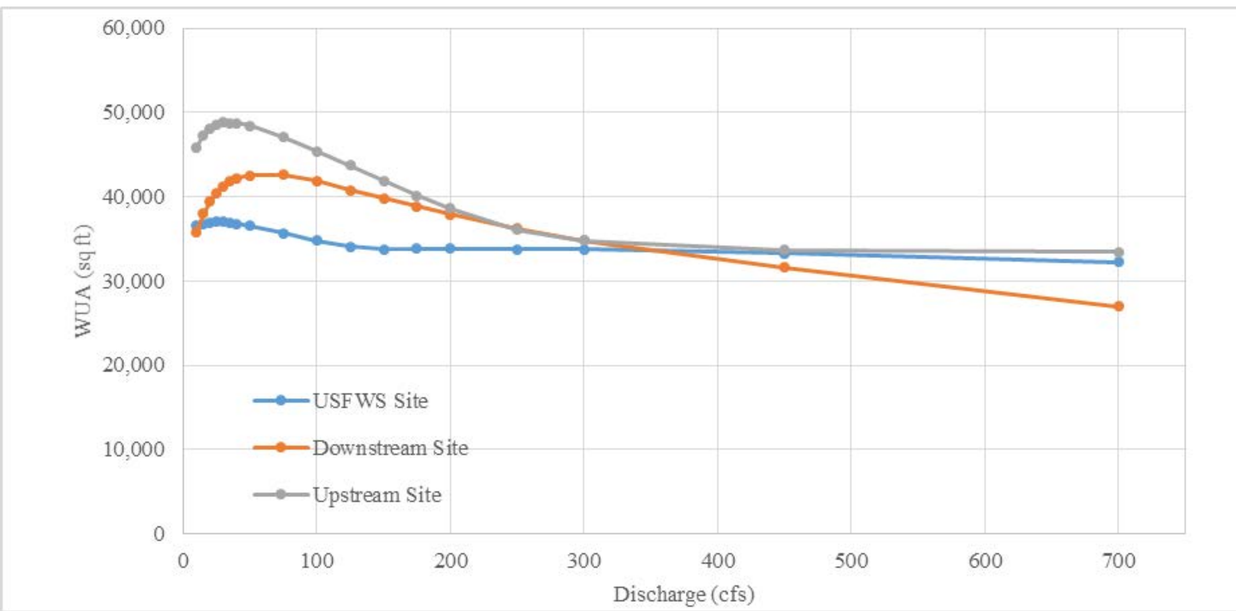

Figure 3.3.3-30. Chinook salmon juvenile rearing WUA at SSWD and USFWS sites.

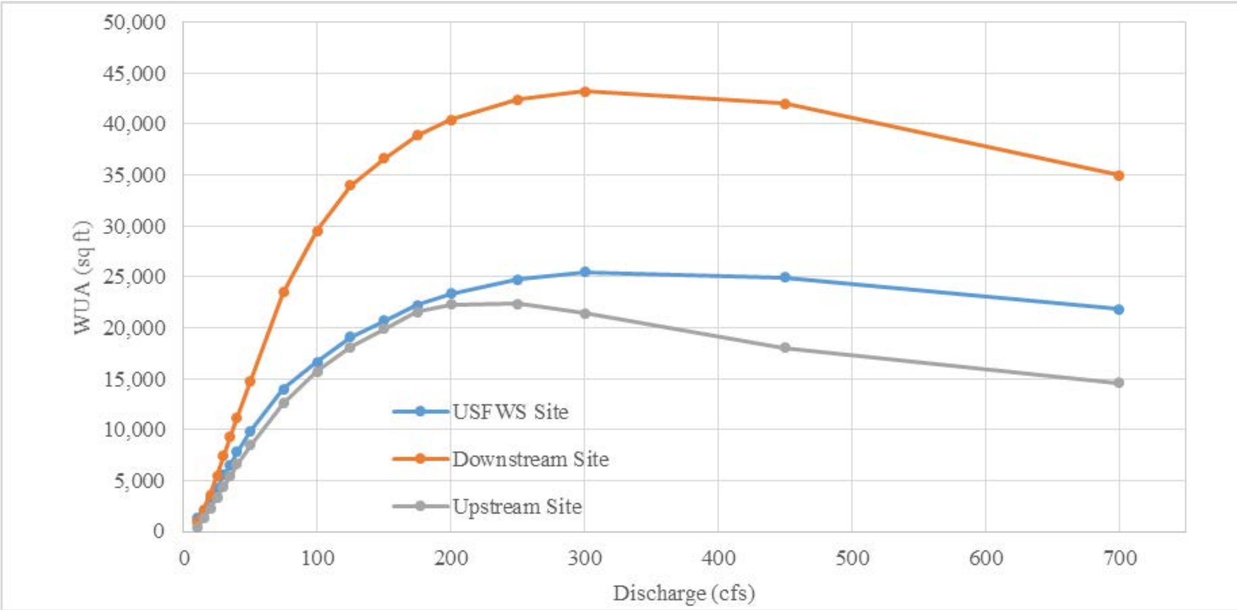

Figure 3.3.3-31. Steelhead spawning WUA at SSWD and USFWS sites.

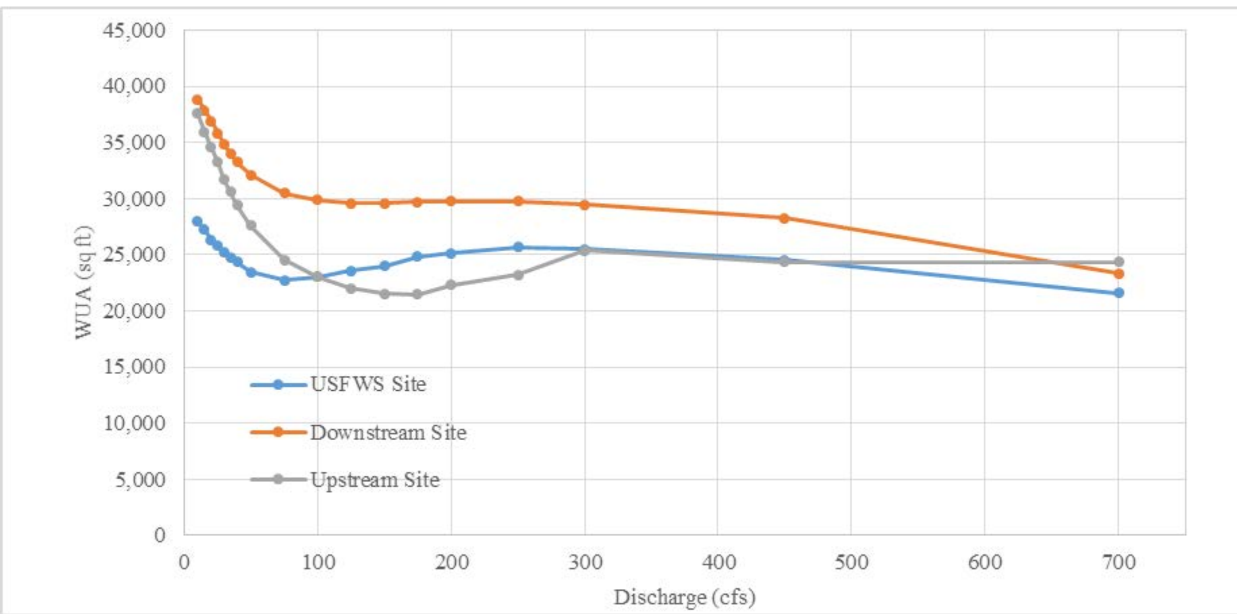

Figure 3.3.3-32. Steelhead fry rearing WUA at SSWD and USFWS sites.

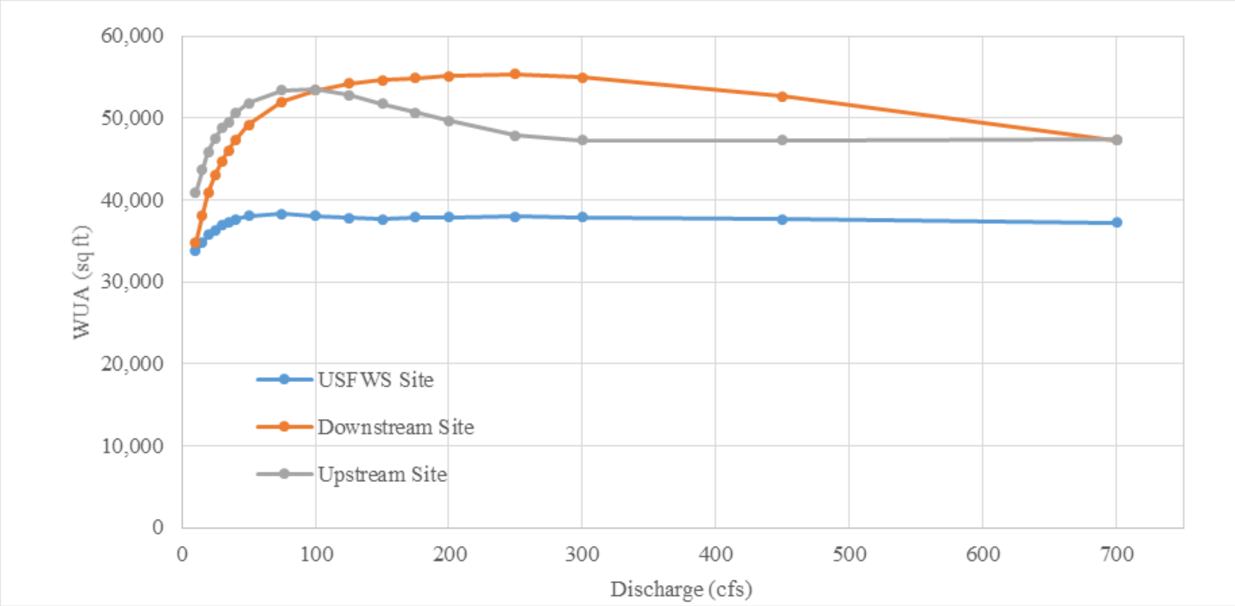

Figure 3.3.3-33. Steelhead juvenile rearing WUA at SSWD and USFWS sites.

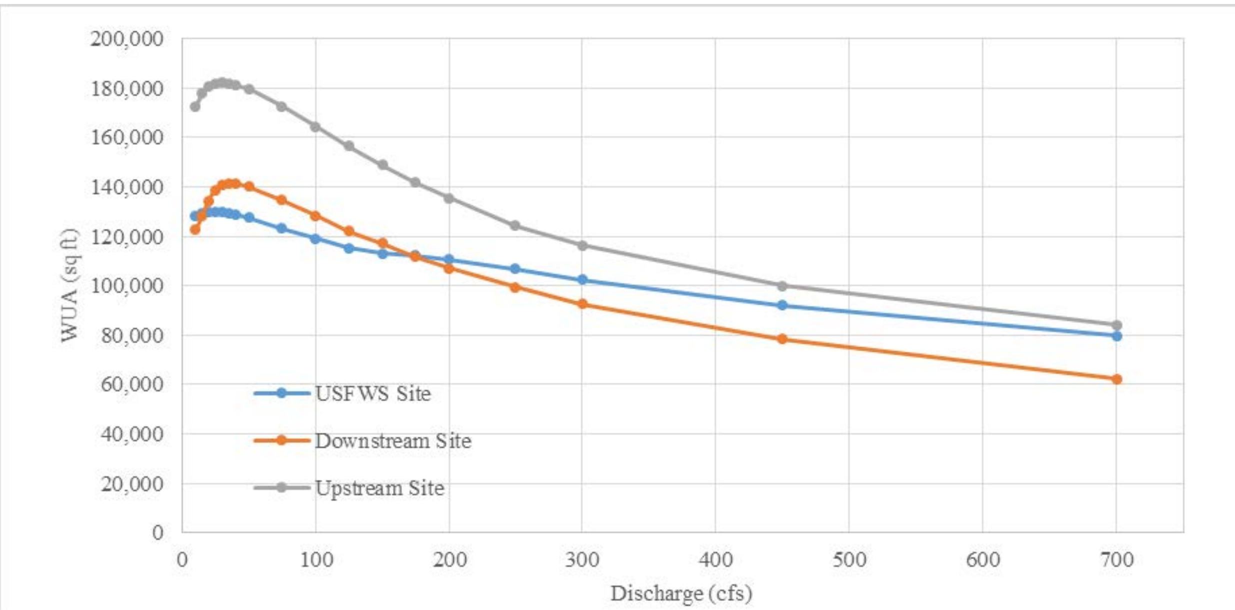

Figure 3.3.3-34. Hardhead juvenile WUA at SSWD and USFWS sites.

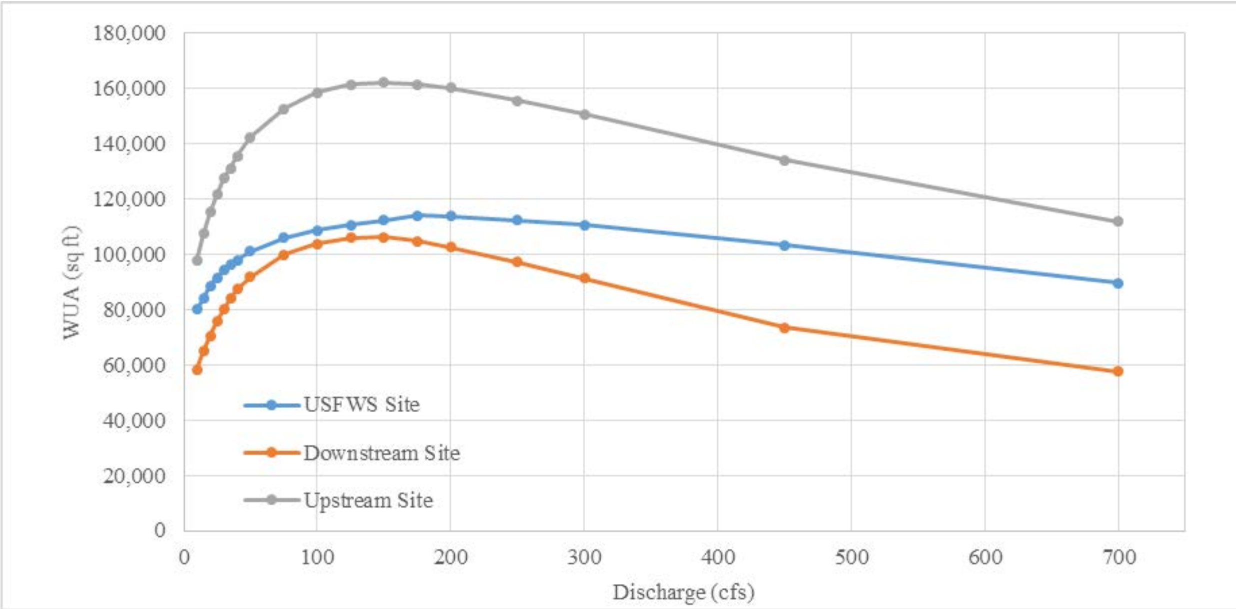

Figure 3.3.3-35. Hardhead adult WUA at SSWD and USFWS sites.

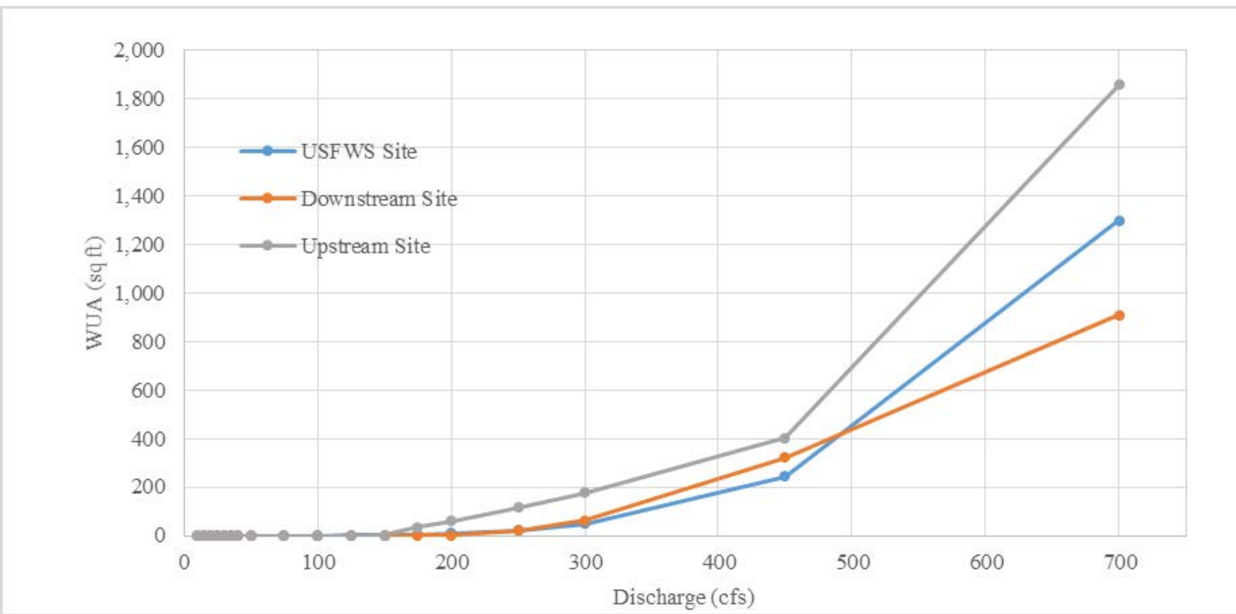

Figure 3.3.3-36. Sturgeon spawning WUA at SSWD and USFWS sites.

Habitat for Chinook Salmon Under Existing Conditions

The Instream Flow Study does not consider temperature as a parameter of suitability and assumes that water temperatures for each life stage of CV fall-run Chinook salmon ESU is adequate. However, this is not true at all times in the lower Bear River. The lower Bear River is a relatively small, valley floor tributary to the Feather River that is a rain-fed watershed and lacks any access to snowpack or water-on-snow freshet runoff. As a result, summer conditions, even pre-Project, would typically be represented by warm, low flows, more akin to a coastal stream than a coldwater Sierran stream. The system can respond rapidly to precipitation, but is highly influenced by ambient warming from late spring into early fall and from releases from upstream water projects. As a result, water temperature is currently a limiting factor to salmonids.

To examine water temperature constraints for CV fall-run Chinook salmon ESU, SSWD developed a water temperature model based on the 1975 to 2014 period of record. The development of this model is discussed in Section 3.3.2.1.2.3 of this Exhibit E. Using its Temp Model, Chinook salmon lifestage usage periodicities in Table 3.3.3-1 and EPA water temperature guidelines in Table 3.3.3-4. SSWD assessed under the No Action Alternative (i.e., Environmental Baseline [current conditions]) the suitability of water temperature in the lower Bear River for the various life stages of CV fall-run Chinook salmon ESU. The evaluation was done at four nodes in the lower Bear River: 1) RM 16.9 immediately downstream of non-Project diversion dam; 2) RM 11.5 at the Highway 65 bridge; 3) RM 6.8 at the Pleasant Grove Road bridge; and 4) RM 3.5 at the Highway 70 bridge. Suitable water temperatures for the lifestage are expressed in terms of the percent of days in each month that stream water temperatures meet EPA guidelines. To do this, SSWD calculated 7DADM water temperatures from the Base Case Temp Model output, which is mean daily water temperature. The results of this analysis by lifestage is presented in Table 3.3.3-30 and discussed below.

Table 3.3.3-30. Percent of days per month where the No Action Alternative stream water temperature at four locations in the lower Bear River is within the EPA guidelines for specific lifestages of CV fall-run Chinook salmon ESU. Temperatures are output from SSWD's Temp Model. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.[11]

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	80%							0%	31%	99%
Highway 65	100%	81%	53%							0%	51%	99%
Pleasant Grove Bridge gage	98%	75%	46%							0%	49%	99%
Highway 70	94%	69%	38%							0%	49%	98%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	99%	99%	85%	34%						100%
Highway 65	100%	98%	78%	63%	14%	0%						100%
Pleasant Grove Bridge gage	100%	97%	75%	57%	7%	0%						100%
Highway 70	100%	96%	72%	54%	4%	0%						100%
CHINOOK SALMON MIGRATION (EPA GUIDELINE: LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							9%	5%	29%	48%	98%	100%
Highway 65							0%	0%	0%	32%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	30%	99%	100%
Highway 70							0%	0%	0%	30%	99%	100%
Number of Days included in Each Month's Analysis (WYs 1976 through 2014)	1,209	1,102	1,209	1,170	1,209	1,170	1,209	1,209	1,170	1,203	1,170	1,209

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

[11] This table shows percent of days with suitable water temperature for the entire period of analysis and as one WY type since the existing license includes only one WY type. Refer to tables 3.3.3-35 through 3.3.3-49 for a similar analysis of percent days with suitable water temperature by the five WY types proposed by SSWD for inclusion in the new license.

CV Fall-run Chinook Salmon ESU Immigration and Staging

CV fall-run Chinook salmon ESU immigration and staging primarily occurs from July through December (Table 3.3.3-4), with minimal activity, if any, occurring July through September. Summer fish observations as part of 2018 Water Transfer Monitoring did not document CV fall-run Chinook salmon ESU adult presence in the lower Bear River. In addition, multiple years of Vaki monitoring on the Yuba River generally shows passage events beginning in small numbers in September and increasing by October. In 2015, adults on the Yuba River were not documented until October 12, 2015 (Yuba RMT 2015) and only began to arrive in moderate numbers in November.

Suitable CV fall-run Chinook salmon migration characteristics are not relatively complex to maintain. Primarily, adults need complete access to spawning grounds, without physical impairment due to obstacle or shallow water barrier. The lower Bear River maintains sufficient continuity for adult access to the spawning grounds and no instream barriers or impediments to passage were noted during any relicensing surveys completed (e.g. habitat mapping, redd mapping and fish sampling). Specific instream habitat models were not developed for this lifestage because of the general simplistic needs do not require advanced modeling to measure suitability.

The EPA provides a temperature guideline of 18°C 7DADM for migrating adult salmon to ensure that adults are not stressed and that potential eggs within females are not compromised due to excessively warm water. Returning adults may become stressed as their food stores deplete during their journey to their natal spawning grounds under excessively high water temperature. Adults generally manage for temperature by holding in cooler water, in the Sacramento or Feather rivers on their return until conditions begin to improve and then continuing upstream migration. Water temperature analyses in Table 3.3.3-30 shows that water temperatures from July through September are unsuitable, and even in October early returning adults may be exposed to unsuitable water temperatures for most of the time. Water temperatures are suitable in November and December. Wetter years expand the window of opportunity for returning adults, while drier years limit access due to temperature. These conditions are typical of any small watershed, particularly in the Central Valley, and would occur regardless of the Project.

CV Fall-run Chinook Salmon ESU Spawning

CV fall-run Chinook salmon ESU spawning can occur in the lower Bear River from October through January (Table 3.3.3-4). Spawning surveys found that significant activity appears to occur in January. SSWD's studies, as described above, show that the lower Bear River contains good quantities of Chinook salmon spawning substrate and the overall capacity for spawning does not appear to be limited by gravel based on general activity observed of adult spawners (i.e. opportunistic observation and carcass counts) and related spatial requirements. The EPA (2003) guidelines state that a cool 13°C 7DADM or less is desired for suitable temperature during spawning. The guideline is relatively cold, especially for fall water temperature in the lower Bear River that has not fully chilled due to seasonal ambient cooling. The low elevation of the Bear River and relatively smaller reservoir does not cool the water as quickly as other watersheds. As a result, as shown in Table 3.3.3-31, water temperatures are not suitable for spawning in October, marginal at best in November (i.e., 31% to 51% of the days suitable, most of which occurs in the wetter water years), and become suitable in December and January. Temperature results appear to correlate with significant spawning activity observed in January during SSWD's redd surveys with moderate amounts or spawning in November and December.

During this period, the existing minimum flow requirement is 10 cfs, and SSWD and CFWID are not diverting water for irrigation at the non-Project diversion dam. At a flow of 10 cfs and based on the habitat-flow relationship in Figure 3.3.3-28 and water temperature, there would be no habitat available in October due to water temperature, and some habitat in November, but only about 30 to 50 percent of the time. The amount of habitat available for spawning in every year in December and January is 9 percent of the maximum WUA (Max WUA) at the Instream Flow Study Upstream Site, 8 percent of Max WUA at the Downstream Site, and 17 percent of Max WUA at the USFWS Site.

CV Fall-run Chinook Salmon ESU Egg Incubation

CV fall-run Chinook salmon ESU egg incubation immediately follows spawning and generally requires 40 to 60 days to complete (Moyle 2002). Since spawning in the lower Bear River mainly occurs from November through January, egg incubation can then extend through March, but can begin as early as October (Table 3.3.3-4). SSWD's studies, as described above, show that CV fall-run Chinook salmon ESU spawning substrate has good permeability for egg incubation and there are extensive quality gravel beds extending throughout the lower reach.

SSWD's relicensing Instream Flow Study does not include a specific egg incubation model, but is encompassed as part of the overall spawning curve. Assuming that salmon are able to successfully spawn in suitable habitat and that sufficient water stage is maintained for covering redds, then the overall conditions for egg incubation are physically met for velocity, depth, and substrate habitat modeling.

The EPA (2003) guideline similarly maintains that 13°C 7DADM is advised through spawning and egg incubation. This results in a similar scenario to spawning with unsuitable water temperatures in October, marginal at best in November (i.e., 30% to 48% of the days suitable, and these occur in the wetter years), suitable in December and January, with decreasing suitability in February and March (i.e., 38% to 80% of the days suitable) (Table 3.3.3-30). While the early window for egg incubation may be limited in some warmer, drier water years, it is anticipated that cooler, wetter years expand the opportunity for both spawning and incubation. The seasonal opportunity driven by precipitation and cooler weather is a strong factor that persisted prior to the Project and still influences the opportunistic salmonid production levels in the lower Bear River.

CV Fall-run Chinook Salmon ESU Fry Rearing

Young fish that have emerged from gravel incubation represent a fry lifestage. CV fall-run Chinook salmon ESU fry rearing may occur in December, but is more likely to occur from January through April (Table 3.3.3-4). SSWD's studies, as described above, show that the lower Bear River contains good structural habitat for fry rearing. Instream Flow Study modeling differentiates fry from juvenile fishes, because they are not strong swimmers and tend to occupy different habitat when compared to the more mature juvenile counterparts. The existing minimum flow requirement is 10 cfs, and SSWD and CFWID are not diverting water for irrigation at the non-Project diversion dam. At a flow of 10 cfs and based on the habitat-flow relationship in Figure 3.3.3-29, the existing minimum flow provides 91 to 100 percent of Max WUA at each of the Instream Flow Study Upstream and Downstream sites and at the USFWS Site. Therefore, habitat for fry rearing does not appear to be limited, based on depth, velocity and substrate.

The EPA (2003) guidelines do not recommend different prescriptions for fry or juvenile developmental stages and only officially identify juvenile rearing. Regardless, the EPA suggests that 16°C 7DADM is an appropriate guideline for rearing salmon of either fry or juvenile. Temperature conditions for fry are suitable from December through February, decline slightly in March, and, except for immediately below the non-Project diversion dam, are generally unsuitable in April and May (Table 3.3.3-30).

CV Fall-run Chinook Salmon ESU Juvenile Rearing

As fry mature, food prey items increase in size, swimming ability improves and the developmental stage transitions to juvenile. CV fall-run Chinook salmon ESU juvenile fish are more robust, can handle quicker water and access a greater range of habitat when compared to fry. Juvenile fish are most likely to be present from January through June (Table 3.3.3-4). The existing minimum flow requirement is 10 cfs, and SSWD and CFWID are not diverting water for irrigation at the non-Project diversion dam. At a flow of 10 cfs and based on the habitat-flow relationship in Figure 3.3.3-30, the existing minimum flow provides 84 to 100 percent of Max WUA at each of the relicensing Instream Flow Study Upstream and Downstream sites and at the USFWS Site. Therefore, habitat for juvenile rearing does not appear to be limited, based on depth, velocity and substrate.

As discussed for fry rearing, the EPA suggests that 16°C 7DADM is an appropriate guideline for rearing salmonids (fry or juvenile developmental stages). Temperature conditions for rearing juveniles are excellent from December through February, begin to decline in April and May, and by June are broadly unsuitable (Table 3.3.3-30). While water may warm in these later months, some studies have shown slightly warmer conditions may improve growth for rearing juvenile fish and may not pose as strong of an impact as once contemplated. Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in Nimbus Hatchery fall-run Chinook salmon at 19°C (Cech and Myrick 1999). Regardless, suitable conditions persist for multiple months and the window for extended rearing likely persists in wetter water years, which would be anticipated under unimpaired conditions prior to the Project as well.

CV Fall-run Chinook Salmon ESU Smoltification

Smoltification is the process of a juvenile freshwater anadromous fish moving into saltwater. The process is a general physiological change that begins in freshwater and requires suitable water temperature to occur. Habitat requirements for CV fall-run Chinook salmon ESU fry or juvenile fishes as discussed above address what is needed during rearing, but water temperature during smoltification is suggested to be 14°C 7DADM by EPA guidelines. Smoltification may begin with downstream movement during the fry stage, and so can occur between mid-December and June (Table 3.3.3-4), which generally remain cooler during the earlier months of this time period. During mid-spring and early summer months, temperature warms and would exceed the EPA guideline.

Habitat for Hardhead Under Existing Conditions

Hardhead Juvenile

Juvenile hardhead habitat is predicted throughout each site excluding swift riffle sections. The most suitable habitat occurs in slow sections and along the margins of pools away from the thalweg, as well as in discrete locations off the main channel. Hardhead juvenile WUA was highest at the Upstream Site for all discharge simulations, followed by the Downstream Site and the USFWS Site, with some variation on either end of the simulation range (Figure 3.3.3-34). Max WUA occurs at 25 cfs for the USFWS Site, 40 cfs for the Downstream Site, and 30 cfs for the Upstream Site; however, any one of these flows provides more than 99 percent of Max WUA at each site.

Hardhead Adult

The models identified adult hardhead habitat throughout each site excluding swift riffle sections. Adult hardhead suitability is similar to juvenile suitability except for preferring deeper habitat and slightly faster velocities. The most suitable habitat occurred in slow, deeper sections of pools away from the thalweg, as well as in discrete locations off the main channel. Hardhead adult WUA was highest at the Upstream Site for all discharge simulations, followed by the USFWS Site and then the Downstream Site (Figure 3.3.3-35). Max WUA occurs at 175 cfs for the USFWS Site, and 150 cfs for the Upstream and Downstream sites. Simulation flows between 40 cfs and 300 cfs produced at least 80 percent of Max WUA at all sites.

Habitat for Sturgeon Under Existing Conditions

Sturgeon spawning habitat was limited to a few locations within each site at the highest flows simulated. Suitable habitat was predicted in deep pools with sufficiently high velocity through the thalweg. For simulations less than 125 cfs, no suitable spawning habitat was identified. For simulations from 125 to 200 cfs suitable habitat remains limited enough that it is likely does not provide any spawning benefit. Suitable spawning habitat increases throughout each simulation at all sites, peaking at the highest modeled flow of 700 cfs. (Figure 3.3.3-36.)

SSWD's Relicensing Benthic Macroinvertebrates Study

Only one source of information was found regarding benthic macroinvertebrates downstream of the project Area. In 2011 and 2013, SWRCB staff conducted studies in the lower Bear River as part of the SWAMP Statewide Perennial Streams Assessment. One of the studies was conducted about 0.3-mi upstream of the Pleasant Grove Bridge (RM 7.2) and the other about 0.5-mi upstream of the Highway 70 Bridge (RM 4.0; SWRCB 2011, SWRCB 2013). While the data provided did not include any benthic macroinvertebrate (BMI) metric calculations, the 14 orders and 24 families identified during sampling suggest a diverse assemblage of benthic macroinvertebrates. However, only seven of the 24 families (25%) were from Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa which suggest a warm water, altered environment (Table 3.3.3-31).

Table 3.3.3-31. Orders and families of aquatic macroinvertebrates that were found at two locations in the lower Bear River (downstream of the Project).

Order	Amphipoda (scuds)	Arhynchobdellida (leeches)	Hydroida (hydra)	Coleoptera (aquatic beetles)	Plecoptera (stoneflies)	Hoplonemertea (worms)
Family	Gammaridae	Erpobdellidae	Hydridae	Elmidae	Perlodidae	Tetrastemmatidae
Order	**Trombidiformes (mites)**	**Veneroida (clams)**	**Basommatophora (snails)**	**Ephemeroptera (mayflies)**	**Trichoptera (caddisflies)**	**Diptera (true flies)**
Family	Sperchontidae	Corbiculidae	Lymnaeidae	Baetidae	Leptoceridae	Chironomidae
	Hygrobatidae	Sphaeriidae	Planorbidae	Leptohyphidae	Hydropsychidae	Simuliidae
	--	--	Ancylidae	Caenidae	Philopotamidae	--
Order	**Hemiptera (true bugs)**	**Odonata (damsel and dragonflies)**	--	--	--	--
Family	Naucoridae	Libellulidae	--	--	--	--
	--	Coenagrionidae	--	--	--	--

Source: SWRCB 2011 and SWRCB 2013.

In 2017, SSWD conducted BMI surveys for Study 3.4. Surveys were conducted at two representative sites on the Bear River between the non-Project diversion dam and the Feather River confluence. Sampling methods conformed to the standard reach wide benthos (RWB) methods for documenting and describing BMI assemblages and physical habitat described by the SWRCB's SWAMP protocol (Ode et al. 2016). Measurements on water chemistry and physical habitat where collected in conjunction with BMI samples.

The sample sites differed in habitat, substrate composition, and transect characteristics (Table 3.3.3-32). The upstream site was dominated by pools, and the downstream site was comprised of pool, run, and riffle habitats. Moving downstream, dominant substrate size shifted from larger to smaller size classes. The shift in substrate composition is likely a function of the more sediment deposition occurring in the reach and geomorphic processes.

Table 3.3.3-32. Water quality and habitat characteristics collected from SSWD's 2017 study at the Bear River downstream of Camp Far West Reservoir.

Category	Metric	Bear River Upstream of Pleasant Grove Bridge	Bear River Downstream of Highway 70 Bridge
Water Quality	Water Temperature (°C)	25.4	25.9
	Dissolved Oxygen (mg/l)	8.6	10.1
	Specific Conductivity (µS/cm)	89	155.7
	pH	7.6	7.78
Site Characteristics	Reach Length (m)	250	150
	Flow (cfs)	15.2	36.4
	Habitat Composition (% of Site)		
	Pool	66	35
	Glide	12	0
	Riffle	19	40
	Run	4	25
	Dominant Thalweg Substrate Composition (% of site)		
	Bedrock	0	0
	Boulder	0	0
	Cobble	10	0
	Gravel, Course	71	35
	Gravel, Fine	15	20
	Sand	0	20
	Fines	0	24

Table 3.3.3-32. (continued)

Category	Metric	Bear River Upstream of Pleasant Grove Bridge	Bear River Downstream of Highway 70 Bridge
Transect Characteristics	Average Sample Plot Depth (cm)	52.5	63.2
	Average Wetted Width (m)	13.5	9.7
	Average Bankful Width (m)	34	16.1
	Average Bankful Height (m)	1.7	1.2
	Riparian Canopy Cover (%)	23	70

Key: µS = microsiemens; cm = centimeters; °C = Celsius; cfs = cubic feet per second; % = percent; µm -= micrometers; mg/l = milligrams/liter; m = meter

BMI samples were collected at the "11" main transects for each site on the Bear River. BMI samples were processed by Ecoanalysts, a qualified taxonomy laboratory that complies with requirements outlined in the SWAMP protocol. Ecoanalysts calculated the California Stream Condition Index (CSCI) scores using BMI data (Table 3.3.3-33). CSCI is California's new assessment tool that translates BMI data into a numerical measurement of stream health. CSCI scores indicate if a stream's health is altered and to what degree as well as reflects ecological structure and the degree of variation of the observed to expected outcome (Rehn et al. 2015). Scores are calculated using two indices, a multi-metric index (MMI) and observed-to-expected (O/E) index. MMI scores reflect ecological structure and function and O/E scores measure taxonomic completeness (Rehn et al. 2015).

The O/E index compares the observed versus expected BMI taxa and measures the biological condition of a site. The MMI index combines several BMI metrics into a single measurement of biological condition (Rehn et al. 2015). The mean CSCI score of reference sites is 1. CSCI scores greater than 1 indicate more complex ecological functioning and taxonomic richness than predicted. As a stream's CSCI score approaches 0, it represents a stream's increased variance from reference conditions and a degradation of the stream's biological conditions (Rehn et al 2015).

An estimated 20,264 organisms were collected from the two sample sites. A randomly sorted subset of 1,381 invertebrates was used to derive BMI metrics. Eight common BMI metrics were calculated for each site and compared to the CSCI predicted value (Table 3.3.3-33). The BMI community upstream of Pleasant Grove was dominated by seed shrimp (Ostrocoda) which made up 94 percent of the sample. The BMI community downstream of Highway 70 was dominated by thee orders: midges (Diptera); Caddisflies (Trichoptera); and mayflies (Ephemeroptera).

The site upstream of Pleasant Grove scored the lower of the two sites. The CSCI score fell into the "very likely altered" status. It was below the expect value for all eight BMI metrics. The second site, downstream of highway 70 had the highest score of 0.70, indicating a "likely altered" state. The site downstream of highway seventy was below the predicted value for all metrics except percent Coleoptera (beetle family).

The BMI communities at both sites were dominated by tolerant species and did not contain intolerant species. Intolerant species refers to macroinvertebrates that are highly susceptible to stream impairment. Shredder taxa were absent from BMI samples. The term Shredder refers to one of the BMI functional feeding groups known for shredding coarse particulate organic matter.

Shredders are found in slower moving water in cold streams where leaf material accumulates (Harrington and Born 1999). Having a high number of shredder taxa can be a good indicator for riparian cover. Both BMI sites scored below the predicted value for taxonomic richness, percent EPT, and percent clinger taxa. EPT percent is an important indicator of stream health because of EPT's sensitivity to disturbance and pollution (Harrington and Born 1999). Variability in site BMI metrics is likely related to differences in habitat complexity. The low species richness is likely related to extremely high flows from the past season.

Table 3.3.3-33. BMI metrics from samples collected from SSWD's 2017 study at the Bear River downstream of Camp Far West Reservoir.

BMI Metrics	Bear River Upstream of Pleasant Grove	Bear River Downstream of Highway 70
ABUNDANCE		
MMI Score	0.49	0.69
CSCI Score	0.47	0.70
Status	Very Likely Altered	Likely Altered
RICHNESS		
Taxonomic Richness	13.55	23.05
Taxonomic Richness Predicted	34.05	33.71
Percent EPT	34	32
Percent EPT predicted	43	44
Percent Coleoptera Taxa	7	13
Percent Coleoptera Taxa Predicted	13	13
INTOLERANCE		
Intolerant Percent	0	0
Intolerant Percent Predicted	15	15
FEEDING		
Percent Clinger Taxa	33	43
Percent Clinger Taxa Predicted	54	50
Shredder Taxa	0	0
Shredder Taxa Predicted	1.8	1.8

Key: MMI = multimetric index; CSCI = California Stream Condition Index; EPT = Ephemeroptera, Plecoptera, Trichoptera

3.3.3.2 Environmental Effects

This section discusses the potential environmental effects of SSWD's Proposed Project, as described in Section 2.2 of this Exhibit E. As part of the Project relicensing, SSWD proposes a Pool Raise, modifications of existing recreation facilities, and modification of the existing Project Boundary. SSWD proposes four measures that will effect aquatic resources: 1) WR1, Implement Water Year Types; 2) AR1, Implement Minimum Streamflows; 3) AR2, Implement Fall and Spring Pulse Flows; and 4) AR3, Implement Ramping Rates. In addition, SSWD assumes its release through December 2035 of up to 4,400 ac-ft of water from July through September (maximum of 37 cfs) in dry and critically dry water years to meet SSWD's Bay-Delta Water Quality Control Plan objectives and consistent with SSWD's water rights will continue outside of relicensing until the SSWD/SWRCB Settlement Agreement expires (Section 2.1.5.2.3). The section below is divided into the following areas: 1) effects of construction-related activities; 2) effects of continued Project O&M.

3.3.3.2.1 Effects of Construction-Related Activities

This section provides a summary of the effects of the construction-related activities associated with the Pool Raise on aquatic resources in the Project Area.

Effects of Construction on Fish and BMI

There would be no change to flow requirements in the new license in the lower Bear River as a result of construction related to the Pool Raise and, therefore, no effect on aquatic habitats, fish, or BMI as a result of construction. SSWD does not anticipate that a scheduled drawdown would be required to facilitate construction: work would proceed during the normal drawdown period. During construction, including relocation of recreation facilities, SSWD would follow all appropriate permit conditions related to water quality and erosion to prevent impacts to aquatic species and habitats in Camp Far West Reservoir.

Effects of Construction on FYLF and WPT

Construction would have no effect on FYLF and WPT. No FYLF or WPT have been documented within or adjacent to the work area, nor is there any appropriate habitat in the area of the proposed work.

Effects of Construction on AIS

Construction would have no effect on AIS, in that the work would not increase the likelihood of these species being introduced to the Project or spreading them outside or to new sites on the Project. The work would be done in the dry, using appropriate equipment, which would be cleaned prior to being brought onto the Project. All recreation construction would be done in existing NSRA and SSRA, so no new sites would be opened for AIS invasion. Further, SSWD will comply with all mitigation measures required under various permits, including those that may relate to preventing the introduction and spread of AIS.

3.3.3.2.2 Effects of Proposed Project Operations and Maintenance

Under SSWD's Proposed Project, water quantity would change, as compared to the No Action Alternative, but any changes to water quality, excluding temperature, would be very minor, as discussed in Section 3.2 in Exhibit E. This section discusses effects of SSWD's Proposed Project on: 1) fish and BMI resources in Camp Far West Reservoir; 2) fish and BMI resources downstream of the Project; 3) FYLF; 4) WPT; and 5) AIS.

Effects on Fish and AIS in Camp Far West Reservoir

Fish in Camp Far West Reservoir would be affected by the Pool Raise. The Pool Raise would create additional storage capacity in Camp Far West Reservoir and, as a result, would create additional shoreline habitat, which would potentially benefit fishes within the Project. The additional storage provided by the Pool Raise would result in a very small increase in the quantity of coldwater stored in the reservoir (Table 3.3.2-21), which may provide additional habitat for coldwater fishes. The additional water surface created by the Pool Raise may also create additional spawning habitat for fishes that utilize the margins of the reservoir (i.e., black bass species).

The Pool Raise would have no effect on AIS in Camp Far West Reservoir.

Effects on Fish in the Lower Bear River

SSWD developed its Proposed Measures WR1, AR1 and AR2 in collaboration with CDFG and USFWS and are continuing to collaborate with these agencies to refine Measure AR3. These flow measures were developed targeting fall-run Chinook salmon with the realization that the Project controls a small amount of water and that this water is warm in summer and fall. With that in mind, SSWD and the agencies developed Measure WR1, Implement Water Year Types, so that, when cool water is available in winter and spring, the key periods for fall-run Chinook salmon, in wetter years the water could be allocated for the benefit of fall-run Chinook salmon. Further emphasis was placed on fall-run Chinook salmon juvenile rearing (i.e., extending the period of suitable conditions, where possible). Measure AR1, Implement Minimum Streamflows, reflects this emphasis with an increase in winter and spring minimum streamflows from existing minimum flows of between 10 to 115 cfs, depending on month and WY type. Minimum streamflows from June through October would be the same, or even slightly less than existing minimum streamflows, recognizing that the water is better used in the winter and spring and no amount of release would substantially improve aquatic habitat over existing conditions in summer and fall, primarily due to ambient warming and the subsequent warm water temperatures. In addition, Measure AR2, Implement Fall and Spring Pulse Flow, would provide a fall pulse flow in Wet, Above Normal, and Below Normal WYs to encourage fall-run Chinook salmon to enter the lower Bear River and spawn, and a spring pulse flow in Below Normal, Dry, and Critically Dry WYs to encourage whatever fall-run Chinook salmon are in the river to outmigrate before conditions in the lower Bear River become unfavorable due to water temperature. Measure AR3, Implement Ramping Rates, would establish ramping rates to protect fall-run Chinook salmon spawning and minimize fish stranding, including for sturgeon. The existing license includes only one water year type and does not include pulse flows or ramping rates.

The discussion below examines the effects to fishes in the lower Bear River that would result from implementing SSWD’s Proposed Measures as compared to the existing condition. The analyses focus on fall-run Chinook salmon.

<u>CV Fall-Run Chinook Salmon Adult Migration, Spawning, and Egg Incubation</u>

As shown in Table 3.3.3-4, SSWD’s Instream Flow Study examined the relationship between streamflows and fall-run Chinook salmon spawning, which can be considered to include the periods of adult migration (July through December), spawning (October through January) and egg incubation (October through March), at three sites in the lower Bear River. In terms of WUA, SSWD’s Proposed Measure AR1 would increase habitat for fall-run Chinook salmon spawning at all three sites and in all WY types (Table 3.3.3-34). The greatest benefits would be in wetter WYs when % Max WUA would be increased from less than 20 percent under existing conditions to more than 90 percent in some months under SSWD’s Proposed Project. Increases would be less in drier WYs because of limited water availability.

Table 3.3.3-34. Percent of maximum weighted usable area (WUA) for fall-run Chinook salmon spawning and embryo incubation under existing minimum streamflows (Environmental Baseline) and SSWD's Proposed Project minimum streamflows. The differences between the two scenarios are also presented. All values are presented as the range in percent of maximum WUA that are observed across the three different Instream Flow Study sites.

Month[1]	Range of Percent of Maximum WUA for Fall-run Chinook Salmon for 3 Instream Flow Study Sites Spawning and Embryo Incubation				
	Wet Water Year	Above Normal Water Year	Below Normal Water Year	Dry Water Year	Critically Dry Water Year
ENVIRONMENTAL BASELINE					
Oct 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Oct 15-31	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Nov 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Nov 15-30	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Dec 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Dec 15-31	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Jan 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Jan 15-31	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Feb 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Feb 15-28	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Mar 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Mar 15-31	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
PROPOSED PROJECT					
Oct 1-14	8 - 17	8 - 17	8 - 17	8 - 17	8 - 17
Oct 15-31	53 - 62	27 - 36	27 - 36	8 - 17	8 - 17
Nov 1-14	82 - 90	61 - 70	33 - 42	20 - 31	8 - 17
Nov 15-30	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Dec 1-14	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Dec 15-31	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Jan 1-14	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Jan 15-31	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Feb 1-14	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Feb 15-28	90 - 96	61 - 70	33 - 42	20 - 31	14 - 24
Mar 1-14	61 - 70	44 - 53	33 - 42	20 - 31	14 - 24
Mar 15-31	61 - 70	44 - 53	33 - 42	20 - 31	14 - 24
DIFFERENCE BEWTEEN ENVIRONMENTAL BASELINE AND PROPOSED RROJECT					
Oct 1-14	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
Oct 15-31	44 - 53	12 - 23	12 - 23	0 - 0	0 - 0
Nov 1-14	68 - 81	51 - 60	25 - 43	12 - 16	0 - 0
Nov 15-30	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Dec 1-14	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Dec 15-31	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Jan 1-14	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Jan 15-31	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Feb 1-14	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Feb 15-28	74 - 87	51 - 60	25 - 43	12 - 16	6 - 8
Mar 1-14	51 - 60	35 - 43	25 - 43	12 - 16	6 - 8
Mar 15-31	51 - 60	35 - 43	25 - 43	12 - 16	6 - 8

[1] The months shown correspond to the fall-run Chinook salmon period for spawning in the lower Bear River, as shown in Table 3.3.3-4.

SSWD's Proposed Measure AR2 would provide a fall pulse flow in wetter years to encourage fall-run Chinook salmon to enter the lower Bear River and spawn, and SSWD's Proposed Measure AR3 would establish ramping rates to minimize fish stranding.

However, the increased flow releases would have some unintended effects on suitable water temperatures because allocating higher flows in spring depletes the coldwater pool in Camp Far West Reservoir. Table 3.3.3-35 through Table 3.3.3-49 show changes in stream temperatures for each Chinook salmon lifestage by comparing 7DADM stream temperatures derived from the output of SSWD's Temp Model for the existing condition and the Proposed Project relative to the EPA water temperature guidelines (2003), and presented by WY type. As shown in Tables 3.3.3-37, -40, -43, -46 and -49, water temperatures for migration generally improve, except in Critically Dry WYs, whereas water temperatures for spawning and egg incubation are less suitable in November in all WYs, with a slight decrease in December in some WY types. The lower water temperature suitability in November, which is marginal under existing conditions, is a reasonable trade-off for the significant improvements in overall habitat.

Table 3.3.3-35. Percent of days per month where, under the existing condition in Wet WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	96%							0%	32%	97%
Highway 65	100%	100%	94%							0%	51%	99%
Pleasant Grove Bridge gage	96%	99%	88%							0%	49%	97%
Highway 70	93%	98%	83%							0%	49%	94%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	100%	78%	34%						100%
Highway 65	100%	100%	100%	100%	31%	0%						100%
Pleasant Grove Bridge gage	100%	100%	100%	97%	20%	0%						100%
Highway 70	100%	100%	100%	91%	13%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							15%	2%	30%	52%	100%	100%
Highway 65							0%	0%	0%	37%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	35%	100%	100%
Highway 70							0%	0%	0%	35%	100%	100%
Number of Days included in Each Month's Analysis (9 Wet WYs)	279	253	279	270	279	270	279	279	270	279	270	279
Minimum Flows (cfs) at which Temp Model was Run	10	10	10	25	25	25	10	10	10	10	10	10

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-36. Percent of days per month where, under the Proposed Project in Wet WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	97%							0%	23%	97%
Highway 65	100%	100%	94%							0%	37%	99%
Pleasant Grove Bridge gage	96%	99%	88%							0%	39%	97%
Highway 70	94%	98%	83%							0%	40%	94%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	100%	81%	41%						100%
Highway 65	100%	100%	100%	100%	34%	0%						100%
Pleasant Grove Bridge gage	100%	100%	100%	98%	20%	0%						100%
Highway 70	100%	100%	100%	92%	13%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							29%	0%	42%	51%	96%	100%
Highway 65							0%	0%	0%	37%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	35%	100%	100%
Highway 70							0%	0%	0%	35%	100%	100%
Number of Days included in Each Month's Analysis (9 Wet WYs)	279	253	279	270	279	270	279	279	270	279	270	279
Minimum Flows (cfs) at which Temp Model was Run	125 125	125 125	60 60	40 40	40 25	25 20	10 10	10 10	10 10	10 50	125 125	125 125

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-37. Net change in suitable water temperature between the Proposed Project and existing condition in Wet WYs, in percent of days per month where stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon ESU. Positive values indicate a benefit from the Proposed Project to the given lifestage at the given location.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	0%	0%	1%							0%	-9%	-3%
Highway 65	0%	0%	0%							0%	-14%	-4%
Pleasant Grove Bridge gage	0%	0%	0%							0%	-10%	-3%
Highway 70	1%	0%	0%							0%	-9%	-2%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	0%	0%	0%	0%	3%	7%						0%
Highway 65	0%	0%	0%	0%	3%	0%						0%
Pleasant Grove Bridge gage	0%	0%	0%	1%	0%	0%						0%
Highway 70	0%	0%	0%	1%	0%	0%						0%
CHINOOK SALMON MIGRATION (EPA GUIDELINE: LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							14%	-2%	12%	-1%	-4%	0%
Highway 65							0%	0%	0%	0%	0%	0%
Pleasant Grove Bridge gage							0%	0%	0%	0%	0%	0%
Highway 70							0%	0%	0%	0%	0%	0%
Number of Days included in Each Month's Analysis (9 Wet WYs)	279	253	279	270	279	270	279	279	270	279	270	279

Key: Green shaded cells indicate more suitable water temperature conditions for that CV fall-run Chinook salmon ESU lifestage under Proposed Project then under existing conditions; red shaded cells indicate less suitable water temperature conditions under Proposed Project then under existing conditions .

Table 3.3.3-38. Percent of days per month where, under the existing condition in Above Normal WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	95%							0%	31%	100%
Highway 65	99%	91%	77%							0%	51%	100%
Pleasant Grove Bridge gage	96%	86%	66%							0%	51%	100%
Highway 70	85%	76%	49%							0%	48%	100%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	100%	89%	26%						100%
Highway 65	100%	100%	95%	98%	19%	0%						100%
Pleasant Grove Bridge gage	100%	100%	96%	86%	5%	0%						100%
Highway 70	100%	96%	89%	79%	3%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							10%	2%	27%	16%	93%	100%
Highway 65							0%	0%	0%	22%	98%	100%
Pleasant Grove Bridge gage							0%	0%	0%	20%	97%	100%
Highway 70							0%	0%	0%	22%	97%	100%
Number of Days included in Each Month's Analysis (9 Above Normal WYs)	279	255	279	270	279	270	279	279	270	279	270	279
Minimum Flows (cfs) at which Temp Model was Run	10	10	10	25	25	25	10	10	10	10	10	10

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-39. Percent of days per month where, under the Proposed Project in Above Normal WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	95%							0%	21%	95%
Highway 65	99%	97%	76%							0%	40%	99%
Pleasant Grove Bridge gage	96%	90%	65%							0%	41%	100%
Highway 70	87%	72%	48%							0%	40%	100%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	100%	92%	46%						100%
Highway 65	100%	100%	94%	98%	24%	0%						100%
Pleasant Grove Bridge gage	100%	100%	93%	86%	5%	0%						100%
Highway 70	100%	97%	85%	78%	2%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							22%	0%	30%	27%	85%	100%
Highway 65							0%	0%	0%	16%	95%	100%
Pleasant Grove Bridge gage							0%	0%	0%	18%	95%	100%
Highway 70							0%	0%	0%	21%	97%	100%
Number of Days included in Each Month's Analysis (9 Above Normal WYs)	279	255	279	270	279	270	279	279	270	279	270	279
Minimum Flows (cfs) at which Temp Model was Run	60 60	60 60	40 40	25 25	25 25	25 20	10 10	10 10	10 10	10 25	60 60	60 60

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-40. Net change in suitable water temperature days between the Proposed Project and existing conditions in Above Normal WYs, in percent of days per month where stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon ESU. Positive values indicate a benefit from the Proposed Project to the given lifestage at the given location.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	0%	0%	0%							0%	-10%	-5%
Highway 65	0%	6%	-1%							0%	-11%	-1%
Pleasant Grove Bridge gage	0%	4%	-1%							0%	-10%	0%
Highway 70	2%	-4%	-1%							0%	-8%	0%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	0%	0%	0%	0%	3%	20%						0%
Highway 65	0%	0%	-1%	0%	5%	0%						0%
Pleasant Grove Bridge gage	0%	0%	-3%	0%	0%	0%						0%
Highway 70	0%	1%	-4%	-1%	-1%	0%						0%
CHINOOK SALMON MIGRATION (EPA GUIDELINE: LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							12%	-2%	3%	11%	-8%	0%
Highway 65							0%	0%	0%	-6%	-3%	0%
Pleasant Grove Bridge gage							0%	0%	0%	-2%	-2%	0%
Highway 70							0%	0%	0%	-1%	0%	0%
Number of Days included in Each Month's Analysis (9 Above Normal WYs)	279	255	279	270	279	270	279	279	270	279	270	279

Key: Green shaded cells indicate more suitable water temperature conditions for that CV fall-run Chinook salmon ESU lifestage under Proposed Project then under existing conditions; red shaded cells indicate less suitable water temperature conditions.

Table 3.3.3-41. Percent of days per month where, under the existing condition in Below Normal WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	80%							0%	36%	100%
Highway 65	100%	68%	45%							0%	57%	97%
Pleasant Grove Bridge gage	99%	56%	37%							0%	57%	96%
Highway 70	96%	49%	28%							0%	53%	96%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	99%	98%	91%	27%						100%
Highway 65	100%	98%	86%	73%	14%	0%						100%
Pleasant Grove Bridge gage	100%	97%	82%	66%	6%	0%						100%
Highway 70	100%	96%	79%	60%	3%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							2%	5%	26%	52%	100%	100%
Highway 65							0%	0%	0%	35%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	31%	100%	100%
Highway 70							0%	0%	0%	31%	100%	100%
Number of Days included in Each Month's Analysis (7 Below Normal WYs)	217	198	217	210	217	210	217	217	210	217	210	217
Minimum Flows (cfs) at which Temp Model was Run	10	10	10	25	25	25	10	10	10	10	10	10

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-42. Percent of days per month where, under the Proposed Project in Below Normal WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	86%							0%	14%	94%
Highway 65	100%	83%	32%							0%	40%	97%
Pleasant Grove Bridge gage	99%	70%	26%							0%	45%	96%
Highway 70	96%	62%	21%							0%	48%	96%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	98%	93%	38%						100%
Highway 65	100%	99%	83%	73%	18%	0%						100%
Pleasant Grove Bridge gage	100%	97%	78%	66%	8%	0%						100%
Highway 70	100%	96%	72%	62%	6%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							16%	2%	34%	59%	94%	100%
Highway 65							0%	0%	0%	32%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	31%	100%	100%
Highway 70							0%	0%	0%	29%	100%	100%
Number of Days included in Each Month's Analysis (7 Below Normal WYs)	217	198	217	210	217	210	217	217	210	217	210	217
Minimum Flows (cfs) at which Temp Model was Run	30 30	30 30	30 30	25 25	25 20	15 10	10 10	10 10	10 10	10 25	30 30	30 30

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-43. Net change in suitable water temperature days between the Proposed Project flow schedule and existing minimum streamflows in Below Normal WYs, in percent of days per month where stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific life stages of CV fall-run Chinook salmon ESU. Positive values indicate a benefit from the Proposed Project to the given lifestage at the given location.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	0%	0%	6%							0%	-22%	-6%
Highway 65	0%	15%	-13%							0%	-17%	0%
Pleasant Grove Bridge gage	0%	14%	-11%							0%	-12%	0%
Highway 70	0%	13%	-7%							0%	-5%	0%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	0%	0%	1%	0%	2%	11%						0%
Highway 65	0%	1%	-3%	0%	4%	0%						0%
Pleasant Grove Bridge gage	0%	0%	-4%	0%	2%	0%						0%
Highway 70	0%	0%	-7%	2%	3%	0%						0%
CHINOOK SALMON MIGRATION (EPA GUIDELINE: LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							14%	-3%	8%	7%	-6%	0%
Highway 65							0%	0%	0%	-3%	0%	0%
Pleasant Grove Bridge gage							0%	0%	0%	0%	0%	0%
Highway 70							0%	0%	0%	-2%	0%	0%
Number of Days included in Each Month's Analysis (7 Below Normal WYs)	217	198	217	210	217	210	217	217	210	217	210	217

Key: Green shaded cells indicate more suitable water temperature conditions for that CV fall-run Chinook salmon ESU lifestage under Proposed Project then under existing conditions; red shaded cells indicate less suitable water temperature conditions under Proposed Project then under existing conditions.

Table 3.3.3-44. Percent of days per month where, under the existing condition in Dry WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	68%							0%	29%	100%
Highway 65	100%	66%	15%							0%	49%	100%
Pleasant Grove Bridge gage	100%	60%	12%							0%	47%	100%
Highway 70	100%	52%	5%							0%	49%	100%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	99%	96%	83%	43%						100%
Highway 65	100%	95%	51%	14%	0%	0%						100%
Pleasant Grove Bridge gage	100%	92%	42%	11%	0%	0%						100%
Highway 70	100%	93%	40%	12%	0%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							11%	5%	34%	59%	99%	100%
Highway 65							0%	0%	0%	40%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	36%	100%	100%
Highway 70							0%	0%	0%	37%	100%	100%
Number of Days included in Each Month's Analysis (9 Dry WYs)	279	255	279	270	279	270	279	279	270	279	270	279
Minimum Flows (cfs) at which Temp Model was Run	10	10	10	25	25	25	10	10	10	10	10	10

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-45. Percent of days per month where, under the Proposed Project in Dry WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	85%							0%	18%	97%
Highway 65	100%	74%	17%							0%	34%	100%
Pleasant Grove Bridge gage	100%	67%	14%							0%	38%	100%
Highway 70	100%	56%	6%							0%	42%	100%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	97%	84%	51%						100%
Highway 65	100%	100%	58%	9%	0%	0%						100%
Pleasant Grove Bridge gage	100%	96%	47%	6%	0%	0%						100%
Highway 70	100%	93%	38%	6%	0%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							12%	7%	37%	68%	99%	100%
Highway 65							0%	0%	0%	42%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	37%	100%	100%
Highway 70							0%	0%	0%	37%	100%	100%
Number of Days included in Each Month's Analysis (9 Dry WYs)	279	255	279	270	279	270	279	279	270	279	270	279
Minimum Flows (cfs) at which Temp Model was Run	20 / 20	20 / 20	20 / 20	20 / 20	15 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	20 / 20	20 / 20

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-46. Net change in suitable water temperature days between the Proposed Project flow schedule and existing minimum streamflows in Dry WYs, in percent of days per month where stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon ESU. Positive values indicate a benefit from the Proposed Project to the given lifestage at the given location.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	0%	0%	17%							0%	-11%	-3%
Highway 65	0%	8%	2%							0%	-15%	0%
Pleasant Grove Bridge gage	0%	7%	2%							0%	-9%	0%
Highway 70	0%	4%	1%							0%	-7%	0%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	0%	0%	1%	1%	1%	8%						0%
Highway 65	0%	5%	7%	-5%	0%	0%						0%
Pleasant Grove Bridge gage	0%	4%	5%	-5%	0%	0%						0%
Highway 70	0%	0%	-2%	-6%	0%	0%						0%
CHINOOK SALMON MIGRATION (EPA GUIDELINE: LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							1%	2%	3%	9%	0%	0%
Highway 65							0%	0%	0%	2%	0%	0%
Pleasant Grove Bridge gage							0%	0%	0%	1%	0%	0%
Highway 70							0%	0%	0%	0%	0%	0%
Number of Days included in Each Month's Analysis (9 Dry WYs)	279	255	279	270	279	270	279	279	270	279	270	279

Key: Green shaded cells indicate more suitable water temperature conditions for that CV fall-run Chinook salmon ESU lifestage under Proposed Project then under existing conditions; red shaded cells indicate less suitable water temperature conditions under Proposed Project then under existing conditions.

Table 3.3.3-47. Percent of days per month where, under the existing condition in Critically Dry WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	99%	48%							0%	27%	100%
Highway 65	99%	71%	15%							0%	42%	100%
Pleasant Grove Bridge gage	98%	64%	12%							0%	39%	100%
Highway 70	99%	64%	13%							0%	45%	100%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	96%	100%	89%	0%						100%
Highway 65	100%	96%	45%	8%	0%	0%						100%
Pleasant Grove Bridge gage	100%	92%	41%	5%	0%	0%						100%
Highway 70	100%	95%	41%	5%	0%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							7%	17%	21%	72%	100%	100%
Highway 65							0%	0%	0%	26%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	22%	100%	100%
Highway 70							0%	0%	0%	23%	100%	100%
Number of Days included in Each Month's Analysis (5 Critically Dry WYs)	155	141	155	150	155	150	155	155	150	155	150	155
Minimum Flows (cfs) at which Temp Model was Run	10	10	10	25	25	25	10	10	10	10	10	10

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-48. Percent of days per month where, under the Proposed Project in Critically Dry WYs, stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon. Temperatures are output from the Temp Model and are expressed as the 7DADM in degrees Celsius. For each lifestage, only months where utilization based on periodicity is expected are shown. Zero percent indicates that no days have suitable water temperatures and 100 percent indicates that all the days have suitable water temperatures.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	100%	100%	80%							1%	22%	95%
Highway 65	99%	76%	17%							0%	33%	100%
Pleasant Grove Bridge gage	98%	67%	13%							0%	33%	100%
Highway 70	99%	66%	14%							0%	37%	100%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	100%	100%	100%	96%	70%	27%						100%
Highway 65	100%	96%	50%	11%	0%	0%						100%
Pleasant Grove Bridge gage	100%	94%	44%	5%	0%	0%						100%
Highway 70	100%	94%	42%	5%	0%	0%						100%
CHINOOK SALMON MIGRATION (LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							15%	18%	18%	59%	91%	100%
Highway 65							0%	0%	0%	26%	100%	100%
Pleasant Grove Bridge gage							0%	0%	0%	22%	100%	100%
Highway 70							0%	0%	0%	23%	100%	100%
Number of Days included in Each Month's Analysis (5 Critically Dry WYs)	155	141	155	150	155	150	155	155	150	155	150	155
Minimum Flows (cfs) at which Temp Model was Run	15 15	15 15	15 15	15 15	15 10	10 10	10 10	10 10	10 10	10 10	10 15	15 15

Key: Blue cells are 100% suitable water temperatures based on EPA guideline; green cells are 80% to 99% suitable; yellow cells are 70% to 79% suitable; orange cells are 60% to 69% suitable; and red cells are less than 60% suitable.

Table 3.3.3-49. Net change in suitable water temperature days between the Proposed Project flow schedule and existing minimum streamflows in Critically Dry WYs, in percent of days per month where stream temperature at four locations in the lower Bear River is less than EPA temperature guidelines for specific lifestages of CV fall-run Chinook salmon ESU. Positive values indicate a benefit from the Proposed Project to the given lifestage at the given location.

Lower Bear River Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHINOOK SALMON SPAWNING/INCUBATION/EMERGENCE (EPA GUIDELINE: LESS THAN 13°C 7DADM)												
Below the non-Project diversion dam	0%	1%	32%							1%	-5%	-5%
Highway 65	0%	5%	2%							0%	-9%	0%
Pleasant Grove Bridge gage	0%	3%	1%							0%	-6%	0%
Highway 70	0%	2%	1%							0%	-8%	0%
CHINOOK SALMON CORE JUVENILE REARING (EPA GUIDELINE: LESS THAN 16°C 7DADM)												
Below the non-Project diversion dam	0%	0%	4%	-4%	-19%	-12%						0%
Highway 65	0%	0%	5%	3%	0%	0%						0%
Pleasant Grove Bridge gage	0%	2%	3%	0%	0%	0%						0%
Highway 70	0%	-1%	1%	0%	0%	0%						0%
CHINOOK SALMON MIGRATION (EPA GUIDELINE: LESS THAN 18°C 7DADM)												
Below the non-Project diversion dam							8%	1%	-3%	-13%	-9%	0%
Highway 65							0%	0%	0%	0%	0%	0%
Pleasant Grove Bridge gage							0%	0%	0%	0%	0%	0%
Highway 70							0%	0%	0%	0%	0%	0%
Number of Days included in Each Month's Analysis (5 Critically Dry WYs)	155	141	155	150	155	150	155	155	150	155	150	155

Key: Green shaded cells indicate more suitable water temperature conditions for that CV fall-run Chinook salmon ESU lifestage under Proposed Project then under existing conditions; red shaded cells indicate less suitable water temperature conditions under Proposed Project then under existing conditions.

CV Fall-Run Chinook Salmon Fry Rearing

As shown in Table 3.3.3-4, SSWD's Instream Flow Study examined the relationship between streamflows and fall-run Chinook salmon fry rearing, which extends from December through April. In terms of WUA, SSWD's Proposed Measure AR1 would decrease habitat for fall-run Chinook salmon fry rearing at all three sites and in all WY types (Table 3.3.3-34). However, in most months, the percent of Max WUA would still be very high with greater than 80 percent of Max WUA. The changes seem reasonable for the significant improvements in other lifestages.

Table 3.3.3-50. Percent of maximum modeled weighted usable area (WUA) for Chinook salmon fry rearing under existing minimum streamflows (Environmental Baseline) and the water-year-type-specific minimum streamflows that would be implemented under the Proposed Project. The differences between the two scenarios are also presented. All values are presented as the range in percent of maximum WUA that are observed across the three different Instream Flow Study sites.

Month[1]	Range of Percent of Maximum WUA for Fall-run Chinook Salmon for 3 Instream Flow Study Sites Fry Rearing				
	Wet Water Year	Above Normal Water Year	Below Normal Water Year	Dry Water Year	Critically Dry Water Year
ENVIRONMENTAL BASELINE					
Dec 15-31	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Jan 1-14	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Jan 15-31	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Feb 1-14	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Feb 15-28	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Mar 1-14	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Mar 15-31	100 - 100	100 - 100	100 - 100	100 - 100	100 - 100
Apr 1-14	91 - 97	91 - 97	91 - 97	91 - 97	91 - 97
Apr 15-30	91 - 97	91 - 97	91 - 97	91 - 97	91 - 97
PROPOSED PROJECT					
Dec 15-31	56 - 82	73 - 86	88 - 95	94 - 99	97 - 100
Jan 1-14	56 - 82	73 - 86	88 - 95	94 - 99	97 - 100
Jan 15-31	56 - 82	73 - 86	88 - 95	94 - 99	97 - 100
Feb 1-14	56 - 82	73 - 86	88 - 95	94 - 99	97 - 100
Feb 15-28	56 - 82	73 - 86	88 - 95	94 - 99	97 - 100
Mar 1-14	73 - 86	82 - 91	88 - 95	94 - 99	97 - 100
Mar 15-31	73 - 86	82 - 91	88 - 95	94 - 99	97 - 100
Apr 1-14	82 - 91	91 - 97	91 - 97	94 - 99	97 - 100
Apr 15-30	82 - 91	91 - 97	91 - 97	94 - 99	97 - 100
DIFFERENCE BEWTEEN ENVIRONMENTAL BASELINE AND PROPOSED RROJECT					
Dec 15-31	-18 - -44	-14 - -28	-5 - -12	-1 - -6	-3 - 0
Jan 1-14	-18 - -44	-14 - -28	-5 - -12	-1 - -6	-3 - 0
Jan 15-31	-18 - -44	-14 - -28	-5 - -12	-1 - -6	-3 - 0
Feb 1-14	-18 - -44	-14 - -28	-5 - -12	-1 - -6	-3 - 0
Feb 15-28	-18 - -44	-14 - -28	-5 - -12	-1 - -6	-3 - 0
Mar 1-14	-14 - -28	-9 - -18	-5 - -12	-1 - -6	-3 - 0
Mar 15-31	-14 - -28	-9 - -18	-5 - -12	-1 - -6	-3 - 0
Apr 1-14	-6 - -9	0 - 0	0 - 0	2 - 3	3 - 6
Apr 15-30	-6 - -9	0 - 0	0 - 0	2 - 3	3 - 6

[1] The months shown correspond to the fall-run Chinook salmon period for fry rearing in the lower Bear River, as shown in Table 3.3.3-4.

SSWD's Proposed Measure AR3 would establish ramping rates to minimize fish stranding.

However, the increased flow releases would have some unintended effects on suitable water temperatures because allocating higher flows in spring depletes the coldwater pool in Camp Far West Reservoir. As shown in Tables 3.3.3-37, -40, -43, -46 and -49, under the Proposed Project suitable water temperatures for rearing would slightly decrease in some months, but overall would slightly improve or not change. The lower river habitats generally improve, except in

Critically Dry WYs, whereas water temperatures for spawning and egg incubation are less suitable in November in all WYs, with a slight decrease in December in some WY types. As with habitat, the changes seem reasonable for the significant improvements in other fall-run Chinook salmon lifestages.

CV Fall-run Chinook Salmon Juvenile Rearing

As shown in Table 3.3.3-4, SSWD's Instream Flow Study examined the relationship between streamflows and fall-run Chinook salmon juvenile rearing, which can be considered to include the periods of juvenile rearing (mid-January through June) and smoltification (mid-December through June) at three sites in the lower Bear River. In terms of WUA, SSWD's Proposed Measure AR1 would have a minor effect on juvenile rearing habitat that is already greater than 90% Max WUA in most months and WY types (Table 3.3.3-34).

Table 3.3.3-51. Percent of maximum modeled weighted usable area (WUA) for Chinook salmon juvenile rearing under existing minimum streamflows (Environmental Baseline) and the water-year-type-specific minimum streamflows that would be implemented under the Proposed Project. The differences between the two scenarios are also presented. All values are presented as the range in percent of maximum WUA that are observed across the three different Instream Flow Study sites.

Month[1]	Range of Percent of Maximum WUA for Fall-run Chinook Salmon at 3 Instream Flow Study Sites Juvenile Rearing				
	Wet Water Year	Above Normal Water Year	Below Normal Water Year	Dry Water Year	Critically Dry Water Year
ENVIRONMENTAL BASELINE					
Jan 15-31	84 - 99	84 - 99	84 - 99	84 - 99	84 - 99
Feb 1-14	84 - 99	84 - 99	84 - 99	84 - 99	84 - 99
Feb 15-28	84 - 99	84 - 99	84 - 99	84 - 99	84 - 99
Mar 1-14	84 - 99	84 - 99	84 - 99	84 - 99	84 - 99
Mar 15-31	84 - 99	84 - 99	84 - 99	84 - 99	84 - 99
Apr 1-14	95 - 100	95 - 100	95 - 100	95 - 100	95 - 100
Apr 15-30	95 - 100	95 - 100	95 - 100	95 - 100	95 - 100
May 1-14	95 - 100	95 - 100	95 - 100	95 - 100	95 - 100
May 15-31	95 - 100	95 - 100	95 - 100	95 - 100	95 - 100
Jun 1-14	95 - 100	95 - 100	95 - 100	95 - 100	95 - 100
Jun 15-30	95 - 100	95 - 100	95 - 100	95 - 100	95 - 100
PROPOSED PROJECT					
Jan 15-31	90 - 96	98 - 100	97 - 100	93 - 100	89 - 99
Feb 1-14	90 - 96	98 - 100	97 - 100	93 - 100	89 - 99
Feb 15-28	90 - 96	98 - 100	97 - 100	93 - 100	89 - 99
Mar 1-14	98 - 100	99 - 100	97 - 100	93 - 100	89 - 99
Mar 15-31	98 - 100	99 - 100	97 - 100	93 - 100	89 - 99
Apr 1-14	99 - 100	95 - 100	95 - 100	93 - 100	89 - 99
Apr 15-30	99 - 100	95 - 100	95 - 100	93 - 100	89 - 99
May 1-14	99 - 100	95 - 100	95 - 100	89 - 99	89 - 99
May 15-31	95 - 100	95 - 100	93 - 100	84 - 99	84 - 99
Jun 1-14	95 - 100	95 - 100	89 - 99	84 - 99	84 - 99
Jun 15-30	93 - 100	93 - 100	84 - 99	84 - 99	84 - 99
DIFFERENCE BEWTEEN ENVIRONMENTAL BASELINE AND PROPOSED PROJECT					
Jan 15-31	-7 - 12	-1 - 16	1 - 13	1 - 9	0 - 5
Feb 1-14	-7 - 12	-1 - 16	1 - 13	1 - 9	0 - 5
Feb 15-28	-7 - 12	-1 - 16	1 - 13	1 - 9	0 - 5
Mar 1-14	-1 - 16	1 - 15	1 - 13	1 - 9	0 - 5
Mar 15-31	-1 - 16	1 - 15	1 - 13	1 - 9	0 - 5
Apr 1-14	-1 - 4	0 - 0	0 - 0	-2 - 0	-6 - 0
Apr 15-30	-1 - 4	0 - 0	0 - 0	-2 - 0	-6 - 0
May 1-14	-1 - 4	0 - 0	0 - 0	-6 - 0	-6 - 0
May 15-31	0 - 0	0 - 0	-2 - 0	-11 - 1	-11 - 1
Jun 1-14	0 - 0	0 - 0	-6 - 0	-11 - 1	-11 - 1

Table 3.3.3-51. (continued)

Month[1]	Range of Percent of Maximum WUA for Fall-run Chinook Salmon at 3 Instream Flow Study Sites Juvenile Rearing				
	Wet Water Year	Above Normal Water Year	Below Normal Water Year	Dry Water Year	Critically Dry Water Year
Jun 15-30	-2 - 0	-2 - 0	-6 - 0	-11 - 1	-11 - 1

[1] The months shown correspond to the fall-run Chinook salmon period for juvenile rearing in the lower Bear River, as shown in Table 3.3.3-4.

SSWD's Proposed Measure AR2 would provide a spring pulse flow in drier years to encourage fall-run Chinook salmon to migrate out of the lower Bear River before conditions became unfavorable, and SSWD's Proposed Measure AR3 would establish ramping rates to minimize fish stranding.

As shown in Tables 3.3.3-37, -40, -43, -46 and -49, water temperatures for juvenile rearing would generally improve, except in Critically Dry WYs.

Summary

Implementing the Proposed Project and the associated WY-type-specific minimum streamflow schedules would beneficially affect fall-run Chinook salmon in the lower Bear River by increasing spawning habitat availability in all proposed WY types, and by maintaining high availability of juvenile rearing habitat in all WY types. There are currently suitable quantities of salmonid spawning habitats and LWM, and the Proposed Project does not alter the mechanisms by which those habitats or habitat features are maintained or diminished. Implementation of ramping rates reduces the potential for any aquatic organisms, including anadromous salmonids and sturgeon, to become stranded as a result of flow fluctuations, while implementation of pulse flows is expected to facilitate initiation of migratory behaviors in anadromous fish species. Implementation of the Proposed Project generally does not substantially improve or reduce water temperature conditions in any WY type, although some minor benefits and detriments to water temperature conditions can be expected across all WY types and fall-run Chinook salmon lifestages.

Direct insight into the thermal responsiveness of the Bear River during elevated flows in July and August was observed during a water transfer in 2018. Project releases increased from 12 cfs to approximately 125 cfs and were maintained from July 2 to August 28, 2018. At the start of the water transfer discharge ramp-up, temperature was 27.5°C at RM 3.5. Temperature reduced to 22.9°C by July 4 as higher discharge moved through the system, but then steadily warmed to 26.2°C by July 19, even though discharge was maintained at 125 cfs. The relatively small coldwater pool available in Camp Far West Reservoir provided only minimal relief at flows 10 times the baseflow. Ambient conditions rapidly began to warm elevated discharges and nullified any thermal cooling benefit. The small storage capacity, low elevation, and warm ambient summer conditions exceeded the Project's ability to provide any meaningful extended thermal offset for coldwater fishes in late spring through fall months.

Additional insights are provided by SSWD's analysis of the thermal characteristics of Camp Far West Reservoir inflow and Project releases that was conducted for both existing conditions and the Proposed Project, which shows that, from June through October or November (depending on WY type), Project releases are cooler than reservoir inflows under either scenario, but the cooler release temperatures still exceed suitable temperature thresholds for salmonid rearing and spawning lifestages, and the benefits are spatially ephemeral and generally lost to ambient air temperatures by Highway 65. Furthermore, at Highway 65, temperatures in the lower Bear River were more similar to reservoir inflow temperatures, indicating that without the Project or Camp Far West Dam in place, the lower Bear River would still not be hospitable to coldwater fish species during the summer and fall months. Details of this analysis are provided in Section 3.3.5.2.2 (existing conditions analysis) and Section 3.3.5.3.1 (Proposed Project analysis) of this Exhibit E.

While not specifically analyzed here, the beneficial effects that implementation of the Proposed Project would provide for fall-run Chinook salmon would likely be realized for other anadromous fish species that opportunistically utilize the lower Bear River when conditions allow (e.g., white sturgeon). Therefore, the Proposed Project would be expected to be beneficial to all anadromous fish species that may utilize the Bear River.

Effects on FYLF

SSWD's Proposed Project would have no effect on FYLF. The Project is located at the western edge of the range for this species, and well below an elevation of 600 ft, where FYLF normally occur (Sycamore Associates 2013).

Effects on WPT

The Proposed Project would have a potentially beneficial effect on WPT. While the Pool Raise may affect potential habitat for this species, this would likely result in an increase to aquatic habitat for WPT within the reservoir. However, this elevation raise would also result in the conversion of 470 linear ft of riverine habitat in the Bear River and 295 linear ft of habitat in Rock Creek for WPT into lacustrine habitat. Both of these habitats are utilized by this species and this increase in water surface elevation should have minimal effect on WPT.

Effects on AIS

The Proposed Project would have no effect on AIS. Recreation at Camp Far West Reservoir, which is the activity most likely to introduce and spread AIS, will continue as it does now. The prevention program portion of the Dreissenid Mussel Assessment Plan should reduce the potential introduction of dreissenid mussels, as well as other AIS that can be introduced and spread through recreation activities. American bullfrog is already present in the Project, at the two sewage ponds near the Project, and generally throughout the region. The Proposed Project would not cause the further spread of American bullfrog.

3.3.3.3 Cumulative Effects

3.3.3.3.1 Fish

The cumulative effects resulting from past, present, and reasonably foreseeable future actions, including the Proposed Project, have the potential to affect fisheries resources in the lower Bear

River. These activities include timber harvest, livestock grazing, mining, and operation of upstream and downstream water projects.

While timber harvest and grazing rates are likely to decline in the future, the effects of past impacts from these activities are likely negative to anadromous salmonids and other native fishes in the lower Bear River and come in the form of altered regimes for flows and sediment delivery, increased stream temperatures, and reduced availability of large woody material. The water projects on the Bear River further these effects by blocking sediment and large woody material from traveling downstream and altering flow and temperature regimes.

Similarly, mining on the scale that occurred in the mid-1800s has ceased, but those activities significantly altered the geology and soils in the Bear River watershed. These activities moved massive amounts of sediments, some of which were deposited in the lower Bear River channel. The effect of that deposition on fishes is mixed, since these gravels were deposited prior to the construction of the water projects and continue to be available to fish in the lower Bear River (e.g., spawning habitat for anadromous fish), despite reduced sediment transport caused by the various water projects, including Camp Far West. Mining activities also introduced mercury and other harmful metals into the Bear River. Camp Far West and the other reservoirs provide an opportunity for these elements to settle and in the case of mercury be bioaccumulated in fish.

The construction and ongoing operation of the various water projects on the Bear River, all of which went into operation prior to the Project, represent the most significant past and present actions in the Project area, and the operators of those projects are predicting increased demand for water in the foreseeable future. The upstream projects affect inflow into the Project, and the non-Project diversion dam immediately downstream of Camp Far West Dam affects the Project's water releases to the lower Bear River. The resulting hydrograph in the lower Bear River is impaired and can be unpredictable. Such a hydrograph likely has negative effects to anadromous salmonids and other native fishes through reduced streamflows (including large run-off flows in spring), which may negatively impact available spawning and rearing habitats and alter stream temperatures.

Another cumulative effect on native Bear River fish is the introduction and persistence of non-native fish species. These species have been introduced by resource agencies, the public, or conveyance from upstream projects. Camp Far West Reservoir provides good habitat for non-native fish (especially black bass species) that compete with native species and could be transported downstream during spill events. Similarly, the Sacramento River basin has also been stocked with non-native fish which are now present in the Bear River.

The net impact of the cumulative effects to anadromous salmonids and other native fishes in the lower Bear River is likely negative and potentially realized in lower productivity and survival rates resulting from reductions in suitable habitats, altered magnitude and timing of stream flows, and increased stream temperatures. However, implementing the Proposed Project would reduce the impact of these cumulative effects by improving aquatic habitat availability in the lower Bear River during the winter and spring months in years when water is more plentiful.

3.3.3.3.2 FYLF

As described above, the Project is located at the western edge of the range for this species, and well below an elevation of 600 ft, where FYLF normally occur (Sycamore Associates 2013).

3.3.3.3.3 WPT

WPT is significantly affected by loss and degradation of existing habitats – ponds, shallow lakes, and low gradients streams – to urban, agricultural, and water development. Historical over-collection for food and the pet trade was likely a major factor in the early decline of the species. Introduction of non-native competing species, particularly other species of turtles and predators; the proliferation of native predators, such as raccoons, in areas of human development; and road mortality also have significant impacts. Although the Project provides potential habitat for WPT in the Project reservoir, deep water reservoirs may represent low quality habitat, with negligible benefit to the species. As a source of predatory fish into tributaries, the Project may contribute to cumulative effects on WPT. In the lower Bear River, historical mining has altered instream and floodplain wetland habitats for WPT; this activity is not associated with the Project, which has no cumulative effect.

3.3.3.4 Unavoidable Adverse Effects

The Proposed Project will continue to capture sediment, truncate high flows, and alter flow and water temperature in the lower Bear River, which may affect fish (and habitat) downstream of the Project. These effects are considered at best beneficial (e.g., slightly cooler water temperatures from the Proposed Project) and at worst long-term, minor impacts that are cumulative in nature when considering the entire Bear River watershed. Instream flow and water temperature modeling shows that simply releasing more flow to provide additional physical habitat will not significantly improve water temperature and therefore not make conditions better overall for threatened or endangered fish species.

The Project will continue to have no other effect on FYLF and WPT than periodically inundating a portion of the Bear River and Rock Creek with slack water as Camp Far West Reservoir is filled. It is unlikely that FYLF or WPT utilize these habitats since these fluctuations happen in most years.

3.3.3.5 Measures or Studies Recommended by Agencies and Not Adopted by SSWD

As described in Appendix E4 in this Exhibit E, USFWS, NMFS, CDFW, SWRCB and FWN each submitted written comments on SSWD's December 29, 2018, DLA. SSWD reviewed each letter or email and, with regards to aquatic resources, identified three individual proposals to modify a SSWD proposed measure or add a new measure. In addition, during discussions with Relicensing Participants, CDFW and others expressed an interest in exploring whether use of the Camp Far West Dam low-level outlet from April 16 through June 30 would improve water temperature conditions for fall-run Chinook salmon during that period. Each of the comments is discussed below.

Camp Far West Reservoir Aquatic Invasive Species Management Plan

In USFWS' April 10, 2019 letter commenting on the DLA, USFWS stated:

> Six aquatic invasive species that are known to occur in the Project area were not addressed adequately in the DLA: Asian clam (*Corbicula fluminea*), Brazilian waterweed (*Egeria densa*), floating water primrose (*Ludwigia peploides* ssp. *Montevidensis*), parrot's feather milfoil (*Myriophyllum aquaticum*), Eurasian watermilfoil (*Myriophyllum spicatum*), and American bullfrog (*Lithobates catesbeianus*). The Commission and Licensee should develop an Aquatic Invasive Management Plan that addresses these and the additional aquatic invasive species that have the potential to occur within the Project area due to their proximal known locations. Management actions related to bullfrogs should be coordinately closely with measures to protect the California red-legged frog. This plan should be developed within one year of license issuance.

In CDFW's April 14, 2019 letter commenting on the DLA, CDFW stated:

> The Department recommends the Licensee develop an Aquatic Invasive Species Management Plan in order to comply with Fish and Game Code 2302. Per the DLA, a search of the USGS Non-indigenous Aquatic Animals database and the CalWeedMapper database and other information, six aquatic invasive species (AIS) occur in Camp Far West Reservoir.

Based on the AIS known from and with the potential to be introduced to the Project, a specific aquatic invasive species management plan is unnecessary. Outside of the FERC relicensing process, SSWD has developed a Dreissenid Mussel Vulnerability Assessment, as required by California State law and Fish and Game Code § 2302 (described in Sections 3.3.3.1.2 and 3.3.3.3.2 in Exhibit E of the FLA), which includes public education provisions for prevention of introduction of dreissenid mussel species. The public education component also applies to other aquatic invasive species. Since prevention is the main management tool for aquatic invasive species, a plan in the new license which duplicates the one required by State law, would not provide added benefit. There are no currently known effective management strategies for the four species located in the FERC Project Boundary - Asian clam, Eurasian milfoil, floating water primrose and American bullfrog, so prevention of further spread also remains the best management tool.

Lower Bear River Aquatic Monitoring Plan for Stream Fish, Macroinvertebrates, Water Temperature, and Water Quality

In USFWS' April 10, 2019 letter commenting on the DLA, USFWS stated:

> The DLA contains no proposal to monitor the status of salmonids within the lower Bear River for the new license period. Without periodic monitoring of these populations, the USFWS is unable to ascertain the long-term effects the Project and resulting PME conditions or how these future license conditions may need to be adjusted to better manage salmonid production. The USFWS requests that the Licensee, agencies, and TLP relicensing team collaboratively develop a reasonable monitoring plan for salmonids within the lower Bear River that allows a comparison of juvenile production and survival between years. The monitoring plan should be finalized within one year of license issuance.

In CDFW’s April 14, 2019 letter commenting on the DLA, CDFW stated:

> Additionally, the Department recommends the Licensee develop a framework for the monitoring of aquatic and water resources. At a minimum, an aquatic and water resources monitoring plan should address the following areas: stream fish, benthic macroinvertebrates, water temperature, and water quality (potentially including mercury bioaccumulation) so that the Licensee and the RP can obtain a baseline and determine if the revised flow and ramping schedule is impacting these suggested parameters.

In FWN’s April 15, 2019 letter commenting on the DLA, FWN stated:

> The DLA does not contain any recommendations or a proposal for monitoring of salmonids in the lower Bear River. The Network believes that monitoring is important in determining the actual benefits of the proposed actions. FWN would like to work with the Licensee and agencies to develop a proposal that can effectively measure and monitor this fish population.

SSWD has not included in its FLA a PM&E measure for monitoring aquatic and water resources for three reasons. First, CDFW, USFWS, and FWN do not provided an adequate description of the rationale, scope or estimated cost for the suggested monitoring so that SSWD can provide a detailed reply to CDFW’s, USFWS’, and FWN’s requests. Without these details, SSWD can only evaluate and reply to CDFW's, USFWS’, and FWN’s suggestions in general terms. Second and in general terms, the need for monitoring is unclear: the best available science shows SSWD's proposed PM&E measures would improve conditions for stream fish including salmonids, BMI and water temperature (water quality is in good condition, and SSWD's proposed PM&E measures would have no effect on water quality) in the lower Bear River, and CDFW, USFWS, and FWN do not suggest a mechanism under normal Project O&M that would negate these improvements. CDFW, USFWS, and FWN provide no basis for monitoring improvements in stream fish, BMI and water temperature that would occur under SSWD's proposal. Monitoring these improvements is not needed because it would not provide additional improvements. Third and in general terms, the use of monitoring data is unclear. Specifically, CDFW, USFWS, and FWN do not describe mechanisms to isolate in monitoring data Project-related effects from non-Project-related effects on these resources, or how the monitoring data would be used to modify license conditions. While monitoring would track changes in stream fish, BMI and water temperature over time, information that may be useful to agencies that are delegated the responsibility to manage these resources, the monitoring would be of no value from a Project license compliance perspective.

Spawning Gravels and Large Woody Material

In its comment letter on the DLA, NMFS states:

> The Project effects on the recruitment of large woody material and spawning gravel should be mitigated for based on the length of the license. Even though these resources are available now, the Project will continue to inhibit the addition of new materials; future sediment/LWM surveys and new substrate augmentation are likely to be needed. This Project effect should be acknowledged and long-term mitigation measures should be developed.

and

> NMFS does not agree that the Project is beneficial to anadromous fish resources in the Bear River. The Project's dam blocks any ongoing recruitment of large woody material and spawning gravels as well as operations altering the natural hydrograph, including the natural recession rates from high to low flows. NMFS also believes that fall-run Chinook salmon are not the only anadromous fish, "that is most sensitive to flow and temperature." CCV steelhead, North American green sturgeon, and CV spring-run Chinook salmon are also seasonal present and are sensitive to changes in flow and water temperature.

SSWD has not included in its FLA a PM&E measure for monitoring or augmenting LWM or spawning gravels in the Bear River downstream of Camp Far West Dam and the non-Project diversion dam for the following reasons. First, NMFS does not provide an adequate description of the rationale, scope, or estimated cost for the suggested monitoring and augmentation so that SSWD can respond in detail to NMFS's request. Without these details, SSWD can only evaluate and reply to NMFS's suggestion in general terms. Second, and in general terms, the need for monitoring is unclear, because the best available science shows that adequate quantities of these resources currently exist and continue to persist in the lower Bear River, and because NMFS does not provide adequate description of a mechanism by which these resources would become depleted in the future. Finally, and also in general terms, the use of monitoring data and utility of LWM and gravel augmentation is unclear. Specifically, NMFS does not describe a mechanism to isolate in monitoring data Project-related effects from non-Project-related effects on these resources, and does not describe how monitoring data would be used to inform and guide augmentation activities.

SSWD clarifies that the Proposed Project, as described in Appendix E2 and evaluated in this section and in Section 3.3.5.3.2, is anticipated to be beneficial to anadromous fish resources in the Bear River because of the inclusion of flow-related measures that are being collaboratively developed by SSWD, agencies and NGOs. While SSWD is collaborating on proposed conditions to provide pulse flows and ramping rates, the proposed flow-related measures do not represent an attempt to mimic the 'natural hydrograph' but simply to provide more favorable conditions for aquatic resources in the lower Bear River. The Bear River does not experience a natural hydrograph because of the cumulative effects of the operations of four projects upstream of Camp Far West and the non-Project diversion dam downstream.

Use of the Low-Level Outlet in Spring to Improve Water Temperatures for Fall-run Chinook Salmon

CDFW and other Relicensing Participants requested SSWD perform a sensitivity run of the Proposed Project with the Temp Model where spill flows from Camp Far West Dam between April 16 and June 30 would be reduced up to the capacity of the Camp Far West Dam's low-level outlet to evaluate whether use of the low-level outlet would improve water temperatures in the Lower Bear River for fall-run Chinook salmon. The objective was to maintain water temperatures in the Bear River below the EPA guideline for juvenile Chinook salmon rearing of 16°C for an extended period of time relative to the Proposed Project.

SSWD performed the analysis and showed that Camp Far West Dam release temperatures are initially cooler when spill flows are diverted through the low-level outlet, but then increase immediately following the spill event, often causing the 7DADM water temperature below the non-Project diversion dam to exceed the EPA guideline for rearing of 16°C up to 2 weeks earlier than under the Proposed Project. Water temperatures were also observed to be warmer below the non-Project diversion dam in the sensitivity run in the fall when releases were switched from the powerhouse to the low-level outlet because releases from the low-level outlet earlier in the year had reduced the coldwater pool available in the fall. Temperature benefits were observed at Highway 65 when spill flows were diverted to the low-level outlet, often keeping the 7DADM below the 16°C guideline for a few days longer. Once spill was over, both scenarios had similar temperature conditions at Highway 65 indicating that temperatures were at equilibrium with the environment.

Results of the sensitivity analysis indicated a net loss of suitable temperature conditions for rearing salmonids downstream of the non-Project diversion dam in spring when spill flow is diverted through the low-level outlet (Table 3.3.3-52).

Table 3.3.3-52. Number of days (and percent of total number of days), by water year type, where 7DADM water temperatures in the lower Bear River below the non-Project diversion dam are less than EPA (2003) guidelines for salmonid rearing (16°C) under the Proposed Project and an alternative scenario where the Camp Far West low-level outlet (LLO) would be utilized in an attempt to reduce stream temperatures in the lower Bear River for the benefit of rearing salmonids. Also shown are the differences in suitable temperature days between the two scenarios – positive differences indicate a benefit from reoperation of the low-level outlet, while negative differences indicate detrimental temperature effects of reoperating the low-level output compared to the Proposed Project.

Scenario	Number and Percent of Days Water Temperatures Meet EPA Guideline for Chinook Salmon Rearing					
	Wet Water Year	Above Normal Water Year	Below Normal Water Year	Dry Water Year	Critically Dry Water Year	All Water Years
Proposed Project	1,562 (88%)	1,610 (91%)	1,236 (90%)	1,586 (89%)	834 (85%)	6,828 (89%)
Use of Low-Level Outlet Alternative	1,592 (90%)	1,562 (88%)	1,227 (89%)	1,585 (89%)	834 (85%)	6,800 (88%)
Difference	**30 (2%)**	**-48 (-3%)**	**-9 (-1%)**	**-1 (0%)**	**0 (0%)**	**-28 (0%)**

The initial benefit of cooler release temperatures often occurred when 7DADM temperatures immediately below the non-Project diversion dam were already less than the EPA temperature guideline in the Proposed Project. A small temperature benefit often occurred at Highway 65, but the negative outcome of increased temperatures below the non-Project diversion dam post-spill outweighs any short-term positive benefits that occur during spill events. For this reason and the cost related to shifting flows to the low-level outlet, SSWD does not propose a measure to sue the low-level outlet in the spring.

3.3.3.6 List of Attachments

Attachment 3.3.3A Final Rating Curves for the Upstream and Downstream Instream Flow Study Sites

Attachment 3.3.3B Final HSC and a Description of the HSC Selection Procedure

Attachment 3.3.3C Fall-Run Chinook and Steelhead Map Sets

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Attachment 3.3.3A

Final Rating Curves for Hydraulic Simulation Modeling of the Upstream and Downstream Sites

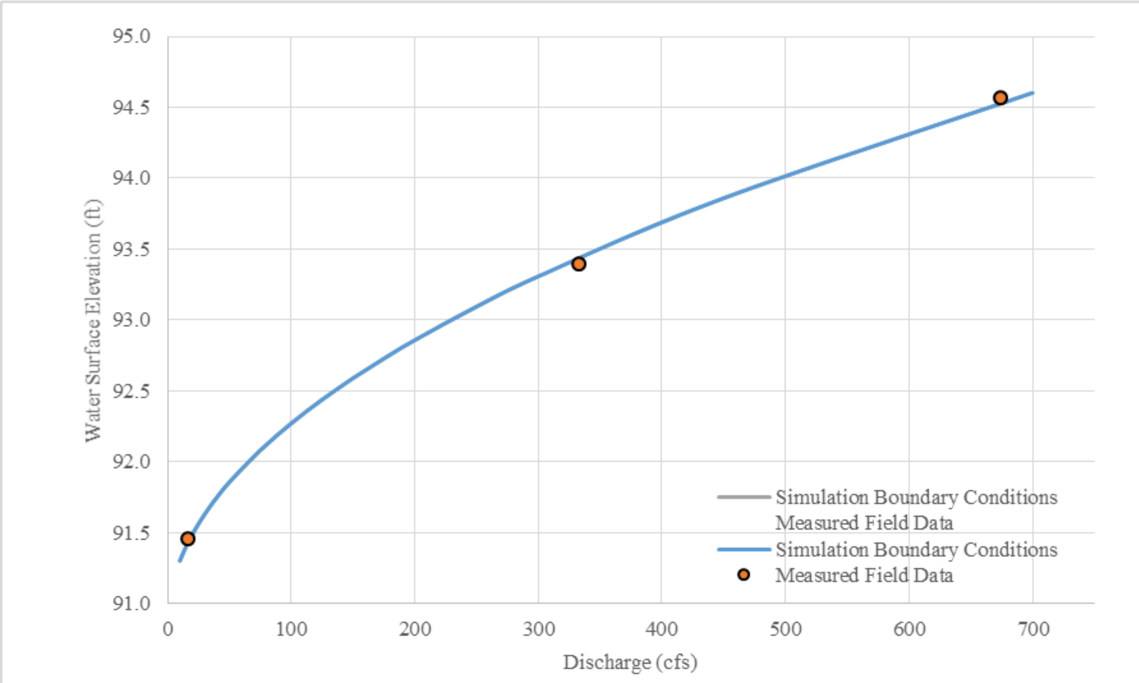

Figure 3.3.3A-1. Final rating curve for boundary conditions at the Upstream Site.

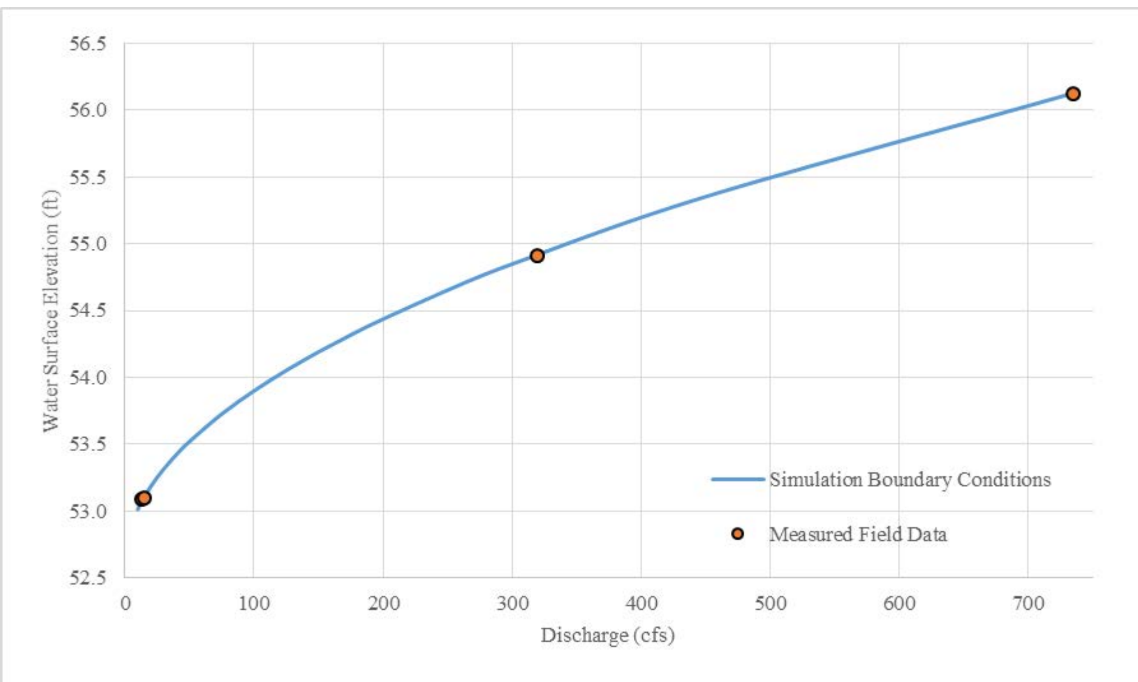

Figure 3.3.3A-2. Final rating curve for boundary conditions at the Downstream Site.

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Attachment 3.3.3B
Habitat Suitability Criteria

Summary of Habitat Suitability Criteria (HSC) for Target Fish Species and Life Stages on the Lower Bear River

The procedures employed for selecting Habitat Suitability Criteria (HSC) for use in assessing instream habitat in the Bear River, California are described below.

HSC were selected through a collaborative process involving a variety of instream flow specialists, as well as the California Department of Fish and Wildlife (CDFW), U.S. fish & Wildlife Service (FWS), and other relicensing participants. Two collaboration meetings were held, the first on July 20, 2018, with a follow-up meeting on August 20, 2018.

Prior to the HSC meeting, a list of proposed target species and life-stages were discussed with the following selections:

Species	Life-stage	Variables*
Chinook Salmon	Spawning	Depth, MC Velocity, Substrate
(fall run)	Fry	Depth, MC Velocity, Cover
	Juvenile	Depth, MC Velocity, Cover
Steelhead	Spawning	Depth, MC Velocity, Substrate
	Fry	Depth, MC Velocity, Cover
	Juvenile	Depth, MC Velocity, Cover
Hardhead	Juvenile	Depth, MC Velocity
	Adult	Depth, MC Velocity
Sturgeon	Spawning	Depth, MC Velocity, Substrate
(white or green)		

*MC Velocity = Mean Column Velocity

This list was presented and agreed upon by the meeting participants. Candidate HSC curves representing each of these species and life-stages were developed prior to the meeting, then presented and discussed until a final HSC curve was approved by everyone in attendance. The list of candidate HSC was developed from a master list of HSC data, which for salmon and steelhead were filtered to a subset of HSC developed from California streams and rivers and applied in previous instream flow studies. The HSC dataset for Chinook salmon, being very large, was further filtered to represent HSC from medium-sized streams similar to the Bear River (e.g., HSC from large rivers such as the Sacramento River, Klamath River, etc. were dropped from consideration). Candidate HSC for steelhead were drawn from all California studies, but emphasis was focused on data from medium-sized rivers. In general, the consensus-selected HSC for these two species relied heavily on HSC from Clear Creek and the lower Yuba River relicensing studies, as well as Big Sur HSC for steelhead fry and juvenile rearing.

Due to the paucity of HSC data for sturgeon spawning (green or white), all available HSC datasets were presented for discussion; however the consensus HSC for use in the Bear River relied on HSC developed and selected for use on the lower Yuba River. Hardhead HSC previously vetted and utilized in the Yuba-Bear Drum-Spaulding instream flow study were presented and selected to represent that species in the Bear River.

Specific notes RE selection of individual HSC for each species and life-stage are presented below. Please refer to the tables at the end of this document for the final HSC curve points.

Chinook Salmon

Spawning. Ten candidate HSC datasets were presented to represent spawning by Chinook Salmon, in addition to site-specific data collected at 73 salmon redds in the Bear River study area. Following discussion of the site-specific data and comparison of candidate HSC curves, a consensus HSC curve for spawning velocity was selected that utilized the Clear Creek fall Chinook curve from 0.9 fps to 1.83 fps, then followed the lower Yuba HSC curve to 5.32 fps (see figures). The consensus HSC for spawning depth likewise followed the Clear Creek fall Chinook HSC from 0.4-1.1 ft, then descended to 5 ft based on consensus and discussion regarding the site-specific characteristics of the Bear River study area. HSC representing spawning substrate for Chinook utilized consensus for gravel less than one inch in diameter, then followed the Clear Creek HSC for substrates dominated by gravels 1-3 inches to gravels ranging from 3-5 inches in diameter.

Fry Rearing. Seven candidate HSC datasets were presented to represent rearing by Chinook salmon. The consensus HSC for mean column velocity for Chinook fry was based on the FWS Yuba River HSC, which was largely adopted for the lower Yuba instream flow study, except the consensus HSC was truncated at 1.8 fps. The consensus HSC for fry depth bracketed the FWS Yuba fry curve from 0.0 to 1.5 ft, but then descended proximal to the lower Yuba curve to 4.0 ft. HSC for fry cover suitability was based on the Clear Creek fall Chinook HSC, except for consensus-based decisions for aquatic vegetation, which was rare in the Bear River.

Juvenile Rearing. The FWS Yuba HSC for juvenile Chinook velocity suitability, subsequently adopted for use in the lower Yuba instream flow study (with slight modifications), was likewise selected for use in the Bear River. In contrast to the FWS and Lower Yuba curves, the Bear consensus curve dropped to zero suitability at 3.0 fps. For juvenile depth, the Bear River participants selected a new curve that utilized components of several existing HSC, including the Battle Creek, Stanislaus River, and lower Yuba curves. Use of instream cover by juvenile Chinook was based on the Clear Creek fall Chinook curve, except suitability was downgraded for aquatic vegetation, as for fry.

Steelhead

Spawning. Eight HSC curves for steelhead spawning were presented, along with site-specific redd data previously collected in the lower Yuba River. Following discussion the Clear Creek HSC for spawning velocity was selected to represent the Bear River. The final Bear HSC for spawning depth was also largely based on the Clear Creek HSC from depths of 0.3 to 2.5 ft, but then the curve dropped along the lower Yuba redd data to an intermediate value at 4 ft, then extended to 10 ft. The maximum depth was based in part on the maximum spawning depths observed in Clear Creek. Spawning substrate HSC for steelhead followed the Clear Creek HSC for substrate sizes up to 1-2 inches, then followed the lower Yuba HSC for larger substrates.

Fry Rearing. Seven HSC datasets were presented as candidate curves for steelhead rearing. The consensus HSC from fry velocity suitability was a curve drawn intermediate to the HSC from Clear Creek and the Big Sur River. The fry depth curve was drawn by consensus to bracket both the Clear Creek and the Big Sur River HSC. Instream cover HSC for steelhead fry was largely based on the Clear Creek HSC, with some adjustments for suitability of cobble and boulder substrates based on Big Sur data, and adjustments to aquatic vegetation suitability based on lower Yuba HSC.

Juvenile Rearing. Consensus HSC representing velocity suitability for juvenile steelhead bracketed the Big Sur HSC, except for velocities less than 0.75 fps which were intermediate to HSC from the Big Sur River and Clear Creek. The final HSC for juvenile depth suitability likewise bracketed the Big Sur HSC, with somewhat higher suitability for depths over 3 ft and maximum depth of 6 ft due to higher values represented by the Clear Creek HSC. As noted for steelhead fry, the cover HSC for juvenile steelhead followed the Clear Creek HSC except for cobble/boulder substrate which was adjusted based on HSC data from the Big Sur River.

Sturgeon

Spawning. As noted above, the HSC selected to represent spawning by green or white sturgeon was taken directly from the HSC selected for use in the lower Yuba River instream flow study.

Hardhead

Juvenile and Adult Rearing. As noted above, the HSC selected to represent juvenile and adult rearing by hardhead were taken directly from the HSC selected for use in the Yuba-Bear Drum-Spaulding instream flow study.

Table 3.3.3B-1. Fall-run Chinook salmon spawning habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Substrate (in. diameter)	Suitability
0.09	0	0.4	0	<0.1	0
0.1	0.06	0.5	0.39	0.1-1	0
0.15	0.08	0.6	0.59	1-2	0.5
0.22	0.1	0.7	0.76	1-3	1
0.29	0.12	0.8	0.88	2-3	0.8
0.36	0.14	0.9	0.95	2-4	0.6
0.43	0.17	1	0.99	3-4	0.3
0.5	0.21	1.1	1	3-5	0
0.57	0.24	1.5	1	4-5	0
0.64	0.29	3	0.2	4-6	0
0.71	0.33	5	0	6-8	0
0.78	0.38	--	--	8-10	0

Table 3.3.3B-1. (continued)

Velocity (fps)	Suitability	Depth (ft)	Suitability	Substrate (in. diameter)	Suitability
0.85	0.43	--	--	8-12	0
0.92	0.48	--	--	>12	0
0.95	0.5	--	--	--	--
0.99	0.53	--	--	--	--
1.06	0.59	--	--	--	--
1.13	0.64	--	--	--	--
1.2	0.7	--	--	--	--
1.27	0.75	--	--	--	--
1.34	0.8	--	--	--	--
1.41	0.84	--	--	--	--
1.48	0.88	--	--	--	--
1.55	0.92	--	--	--	--
1.62	0.95	--	--	--	--
1.69	0.97	--	--	--	--
1.76	0.99	--	--	--	--
1.83	1	--	--	--	--
2.95	1	--	--	--	--
3.25	0.5	--	--	--	--
5.32	0	--	--	--	--

Table 3.3.3B-2. Fall-run Chinook salmon fry rearing habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Cover Code	Cover Description	Suitability
0	1	0	0	0.1	none	0.33
0.1	0.99	0.2	0.85	1	cobble	0.33
0.2	0.95	0.4	1	2	boulder	0.33
0.3	0.89	1.5	1	3	fine woody veg (<1")	1
0.4	0.81	3	0.25	3.7	3+ovh	1
0.6	0.65	4	0	4	branches	1
0.7	0.56	--	--	4.7	4+ovh	1
0.8	0.49	--	--	5	log (>1' diam)	1
0.9	0.42	--	--	5.7	5+ovh	1
1.1	0.3	--	--	7	ovh (>2' abv sub)	0.33
1.3	0.22	--	--	8	ucb	1
1.8	0	--	--	9	aq veg	0.2
--	--	--	--	9.7	9+ovh	0.2
--	--	--	--	10	rip-rap	0.33

Table 3.3.3B-3 Fall-run Chinook salmon juvenile rearing habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Cover Code	Cover Description	Suitability
0	1	0.2	0	0.1	none	0.33
0.1	1	1.25	1	1	cobble	1
0.2	0.99	1.5	1	2	boulder	0.33
0.3	0.98	2.1	1	3	fine woody veg (<1")	0.33
0.4	0.97	3	0.4	3.7	3+ovh	1
0.5	0.96	7	0	4	branches	1
0.6	0.94	--	--	4.7	4+ovh	1
0.7	0.92	--	--	5	log (>1' diam)	1
0.8	0.89	--	--	5.7	5+ovh	1
0.9	0.87	--	--	7	ovh (>2' abv sub)	0.33
1	0.84	--	--	8	ucb	1
1.1	0.81	--	--	9	aq veg	0.24
1.2	0.78	--	--	9.7	9+ovh	0.24
1.3	0.74	--	--	10	rip-rap	0.33
1.4	0.71	--	--	--	--	--
1.5	0.67	--	--	--	--	--
1.6	0.63	--	--	--	--	--
1.7	0.6	--	--	--	--	--
1.8	0.56	--	--	--	--	--
1.9	0.52	--	--	--	--	--
2	0.48	--	--	--	--	--
2.1	0.45	--	--	--	--	--
2.2	0.41	--	--	--	--	--
3	0	--	--	--	--	--

Table 3.3.3B-4. Steelhead spawning habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Substrate (in. diameter)	Suitability
0.6	0	0.3	0	0.1	0
0.61	0.08	1	1	1	0.38
0.7	0.14	2.5	1	1-2	1
0.8	0.25	4	0.3	1-3	0.85
0.9	0.38	10	0	2-4	0.28
1	0.53	--	--	3-5	0.16
1.1	0.66	--	--	4-6	0.05

Table 3.3.3B-4. (continued)

Velocity (fps)	Suitability	Depth (ft)	Suitability	Substrate (in. diameter)	Suitability
1.2	0.78	--	--	6-8	0
1.3	0.87	--	--	8-10	0
1.4	0.94	--	--	8-12	0
1.5	0.98	--	--	>12	0
1.6	1	--	--	--	--
1.7	1	--	--	--	--
1.8	0.99	--	--	--	--
1.9	0.97	--	--	--	--
2	0.95	--	--	--	--
2.1	0.93	--	--	--	--
2.2	0.9	--	--	--	--
2.3	0.87	--	--	--	--
2.4	0.85	--	--	--	--
2.5	0.82	--	--	--	--
2.6	0.8	--	--	--	--
2.7	0.78	--	--	--	--
2.8	0.76	--	--	--	--
2.9	0.73	--	--	--	--
3	0.7	--	--	--	--
3.1	0.66	--	--	--	--
3.2	0.61	--	--	--	--
3.3	0.56	--	--	--	--
3.4	0.49	--	--	--	--
3.5	0.41	--	--	--	--
3.6	0.33	--	--	--	--
3.7	0.25	--	--	--	--
3.8	0.17	--	--	--	--
3.89	0.11	--	--	--	--
3.9	0	--	--	--	--

Table 3.3.3B-5. Steelhead fry rearing habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Cover Code	Cover Description	Suitability
0	1	0	0	0.1	none	0.33
0.1	1	0.1	1	1	cobble	0.75
0.25	1	0.75	1	2	boulder	0.33
1	0.2	2	0.2	3	fine woody veg (<1")	0.66
3.6	0	4	0	3.7	3+ovh	1
--	--	--	--	4	branches	0.66
--	--	--	--	4.7	4+ovh	1
--	--	--	--	5	log (>1' diam)	1

Table 3.3.3B-5. (continued)

Velocity (fps)	Suitability	Depth (ft)	Suitability	Cover Code	Cover Description	Suitability
--	--	--	--	5.7	5+ovh	1
--	--	--	--	7	ovh (>2' abv sub)	0.66
--	--	--	--	8	ucb	1
--	--	--	--	9	aq veg	0.5
--	--	--	--	9.7	5+ovh	0.5
--	--	--	--	10	rip-rap	0.33

Table 3.3.3B-6. Steelhead juvenile rearing habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Cover Code	Cover Description	Suitability
0	0.7	0	0	0.1	none	0.31
0.5	1	1	1	1	cobble	0.75
1.5	1	2	1	2	boulder	0.6
3.5	0.1	4	0.2	3	fine woody veg (<1")	0.4
5.6	0	6	0	3.7	3+ovh	1
--	--	--	--	4	branches	1
--	--	--	--	4.7	4+ovh	1
--	--	--	--	5	log (>1' diam)	1
--	--	--	--	5.7	5+ovh	1
--	--	--	--	7	ovh (>2' abv sub)	1
--	--	--	--	8	ucb	1
--	--	--	--	9	aq veg	0.4
--	--	--	--	9.7	5+ovh	0.4
--	--	--	--	10	rip-rap	0.4

Table 3.3.3B-7. Hardhead juvenile habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability
0	1	0.5	0
0.25	1	0.67	1
1.75	0.25	3.67	1
2.6	0	8.71	0.1
--	--	18	0.1

Table 3.3.3B-8. Hardhead adult habitat suitability criteria.

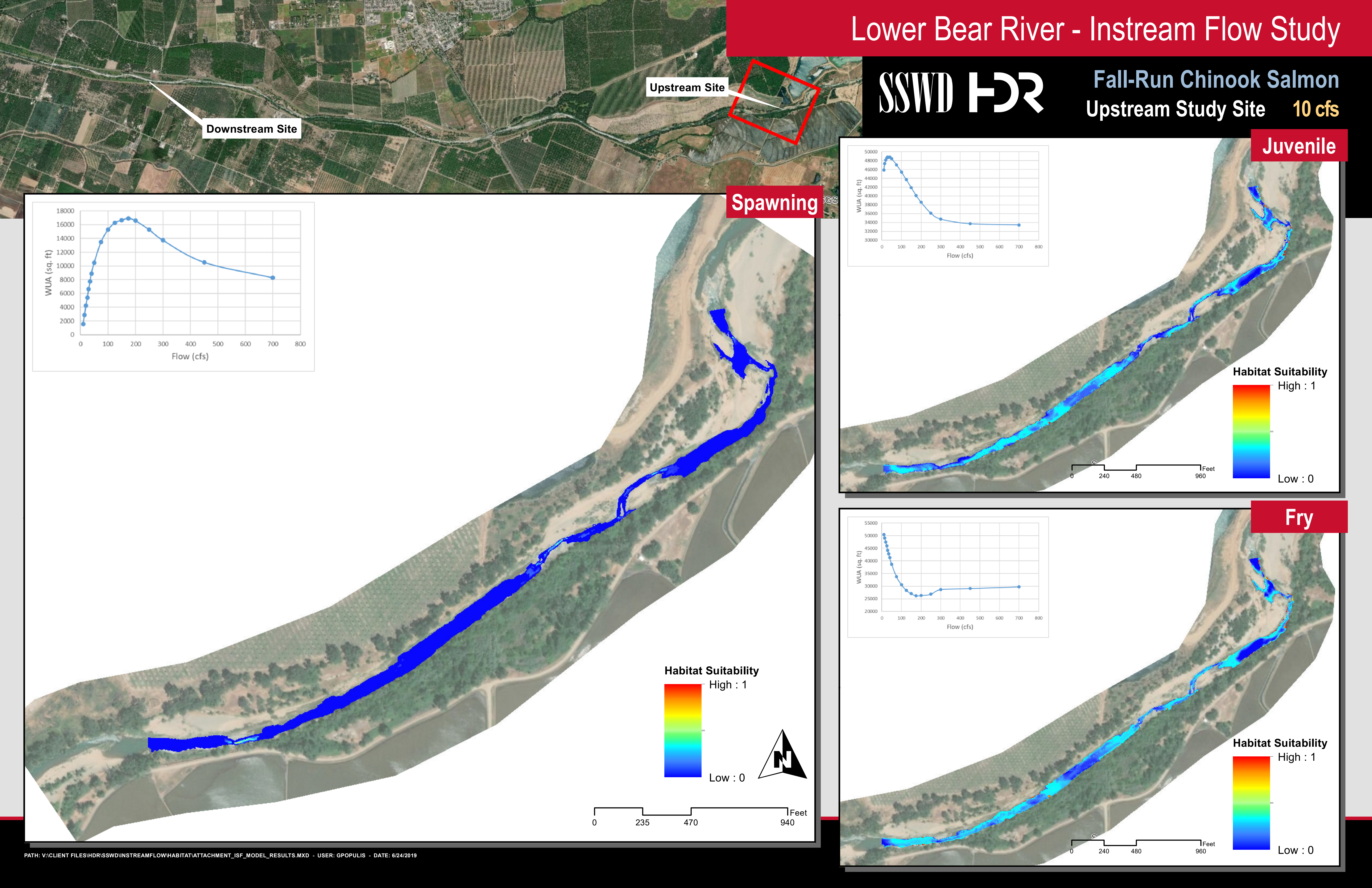
Velocity (fps)	Suitability	Depth (ft)	Suitability
0	0.82	0.66	0
0.2	1	2.62	1
0.9	1	18	1
2.13	0.22	--	--
3.5	0	--	--

Table 3.3.3B-9. Sturgeon spawning habitat suitability criteria.

Velocity (fps)	Suitability	Depth (ft)	Suitability	Substrate Category	Suitability
1.6	0	5	0	snags	0
3.6	1	10	1	organics	0
10	1	100	1	hard clay	0
15	0	--	--	silt/fine clay	0
--	--	--	--	sand	0.1
--	--	--	--	gravel	1
--	--	--	--	cobble	1
--	--	--	--	boulder	0.75
--	--	--	--	bedrock	0.4

Attachment 3.3.3C
Weighted Usable Area Map Sets

Maps Summarizing the Location and Quality of Fall-Run Chinook Salmon and Steelhead Habitat at the Upstream and Downstream Sites Modeled by SSWD


Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Upstream Study Site
10 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
0
100
200
300
400
500
600
700
800
Habitat Suitability
High : 1
Low : 0
0
235
470
940
Feet
Juvenile
WUA (sq. ft)
Flow (cfs)
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
0
100
200
300
400
500
600
700
800
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
Fry
WUA (sq. ft)
Flow (cfs)
20000
25000
30000
35000
40000
45000
50000
55000
0
100
200
300
400
500
600
700
800
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
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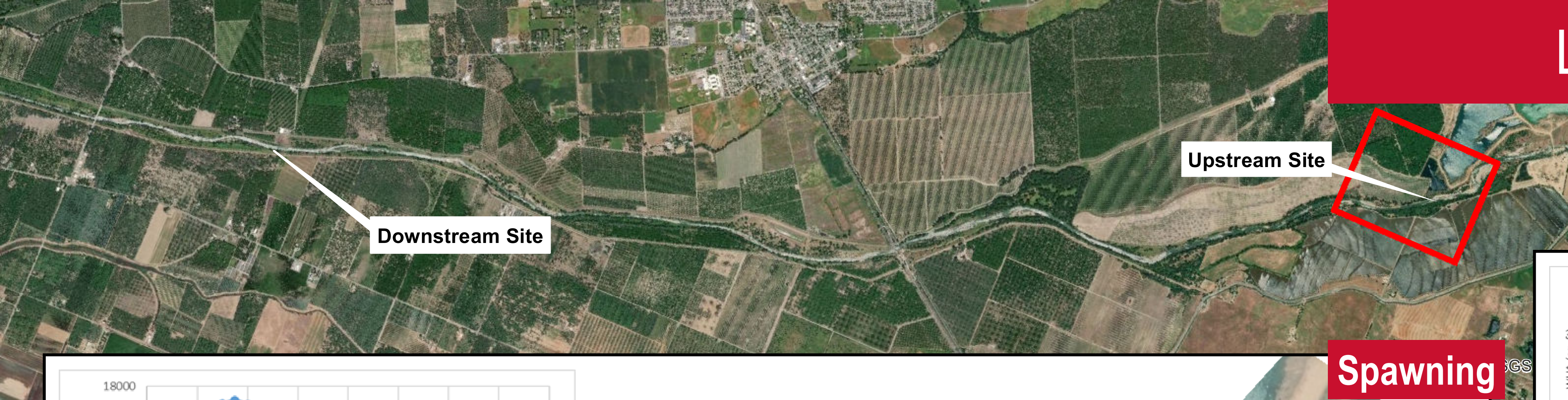
Lower Bear River - Instream Flow Study

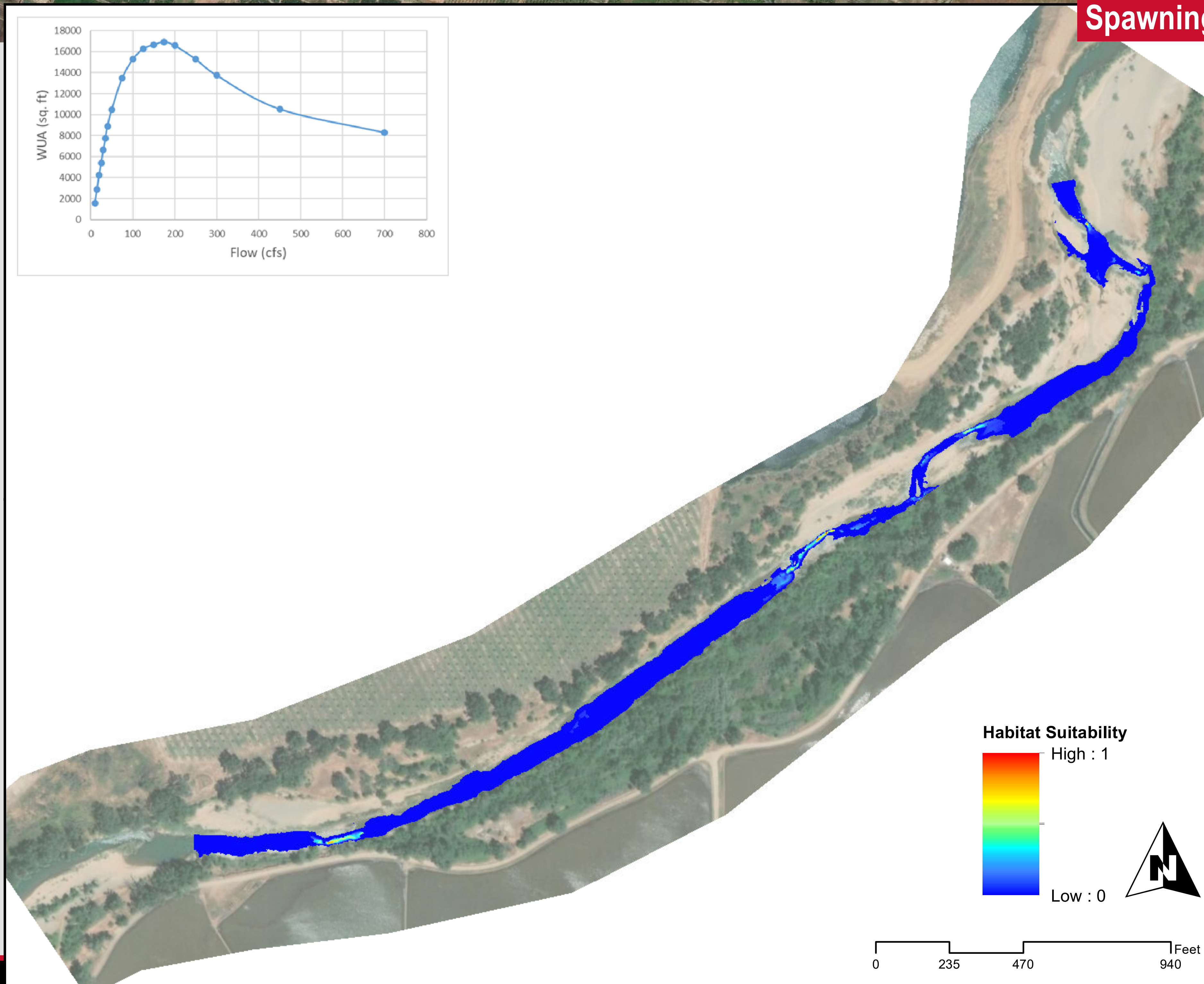
SSWD HDR

Fall-Run Chinook Salmon

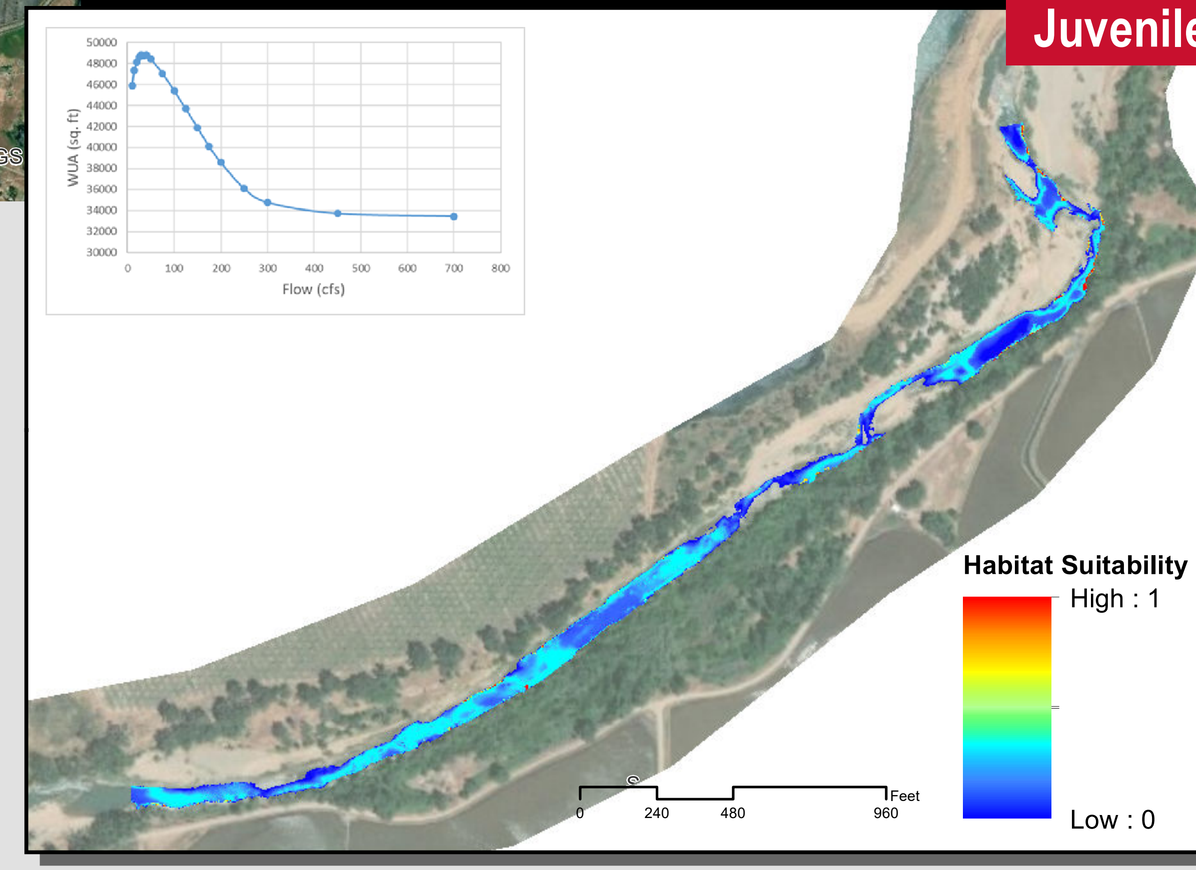
Upstream Study Site 15 cfs



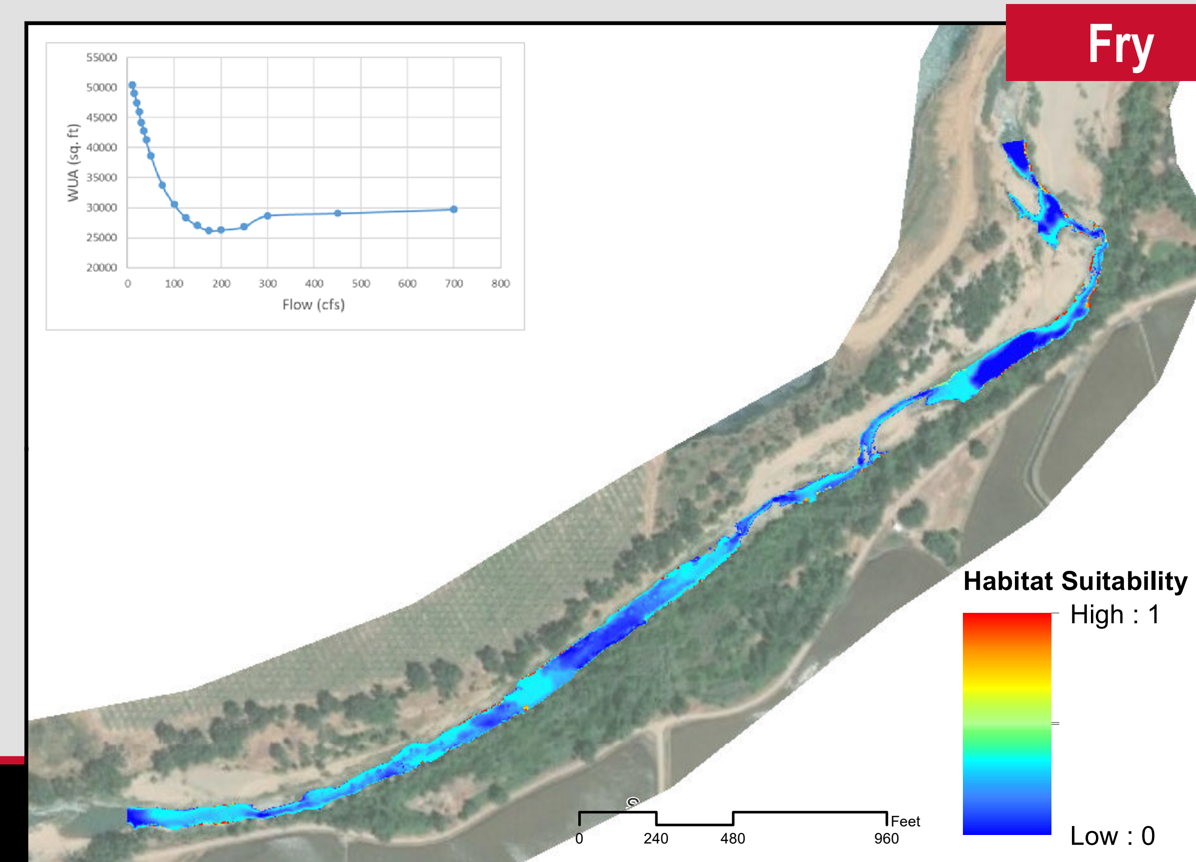
Spawning



Juvenile



Fry



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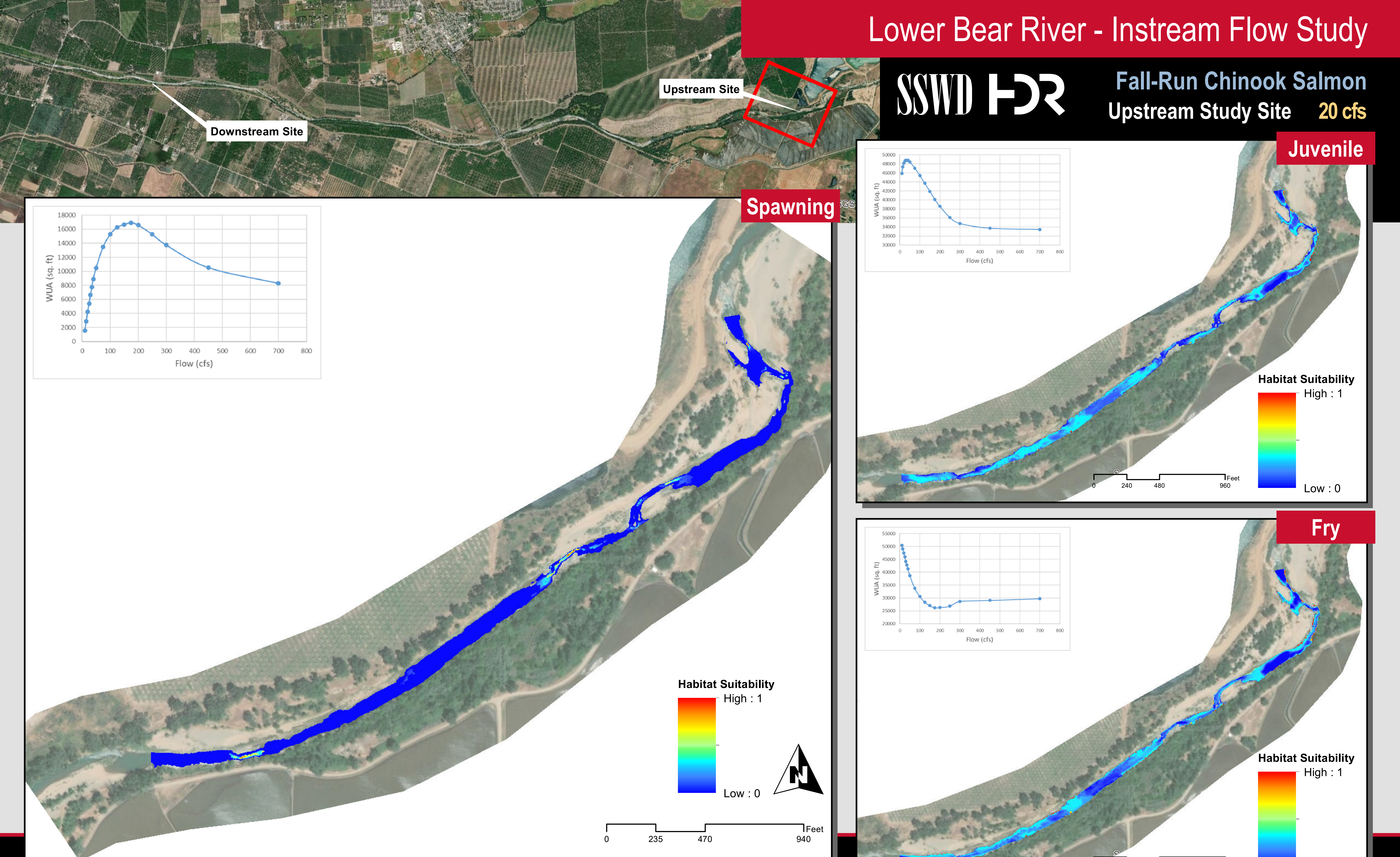

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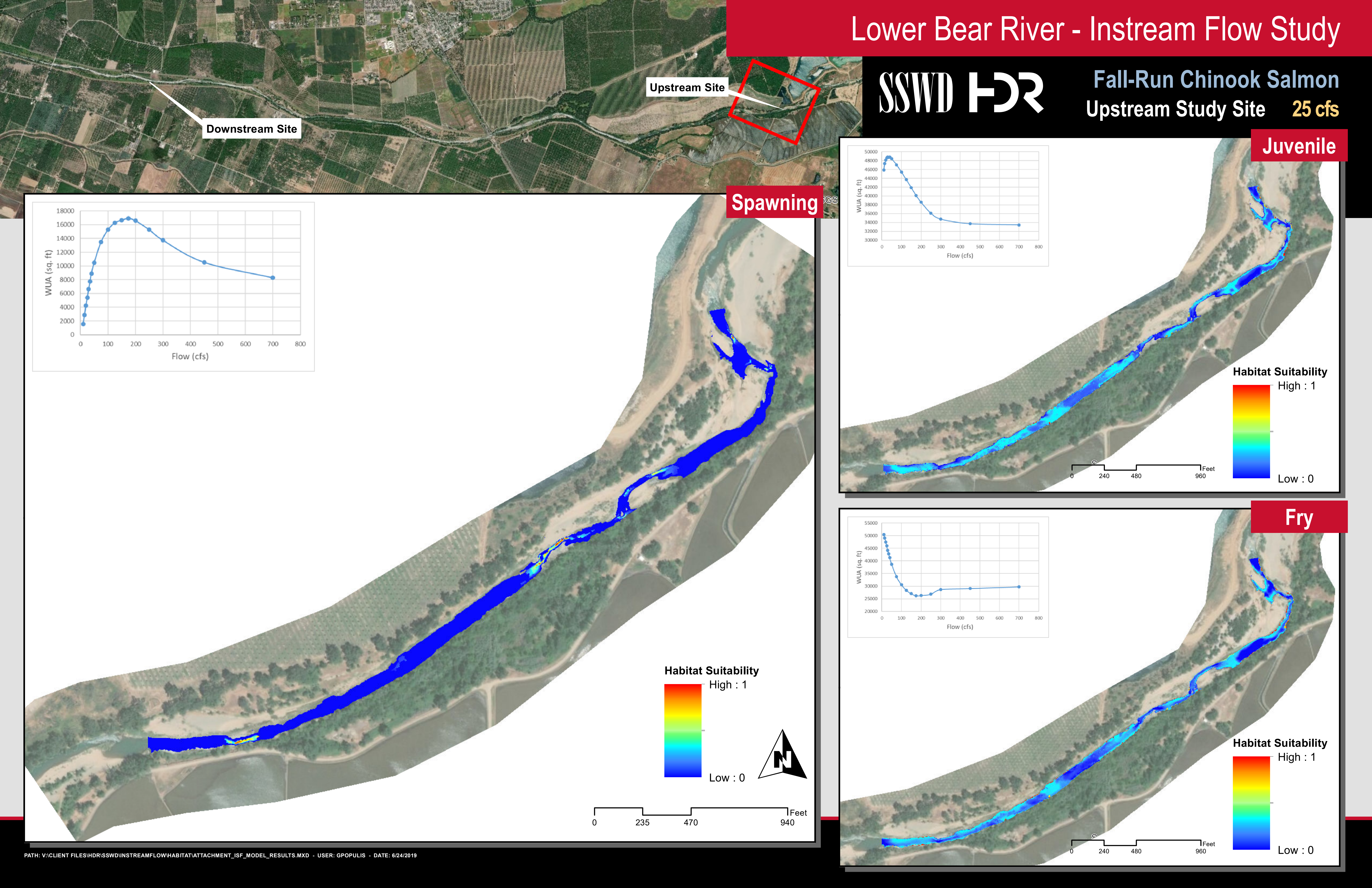
Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Upstream Study Site
25 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
235
470
940
N
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
240
480
960
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
240
480
960
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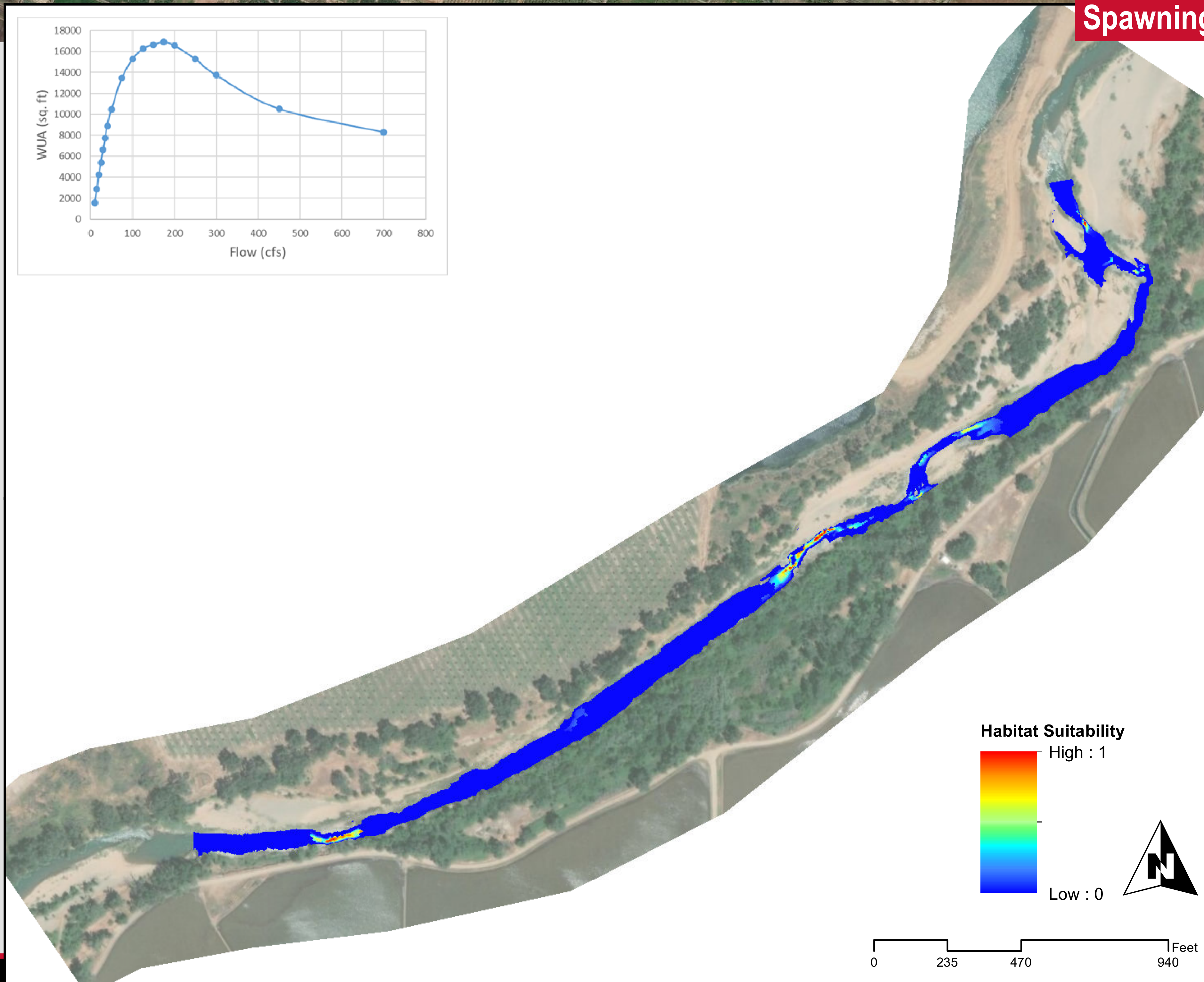
Lower Bear River - Instream Flow Study

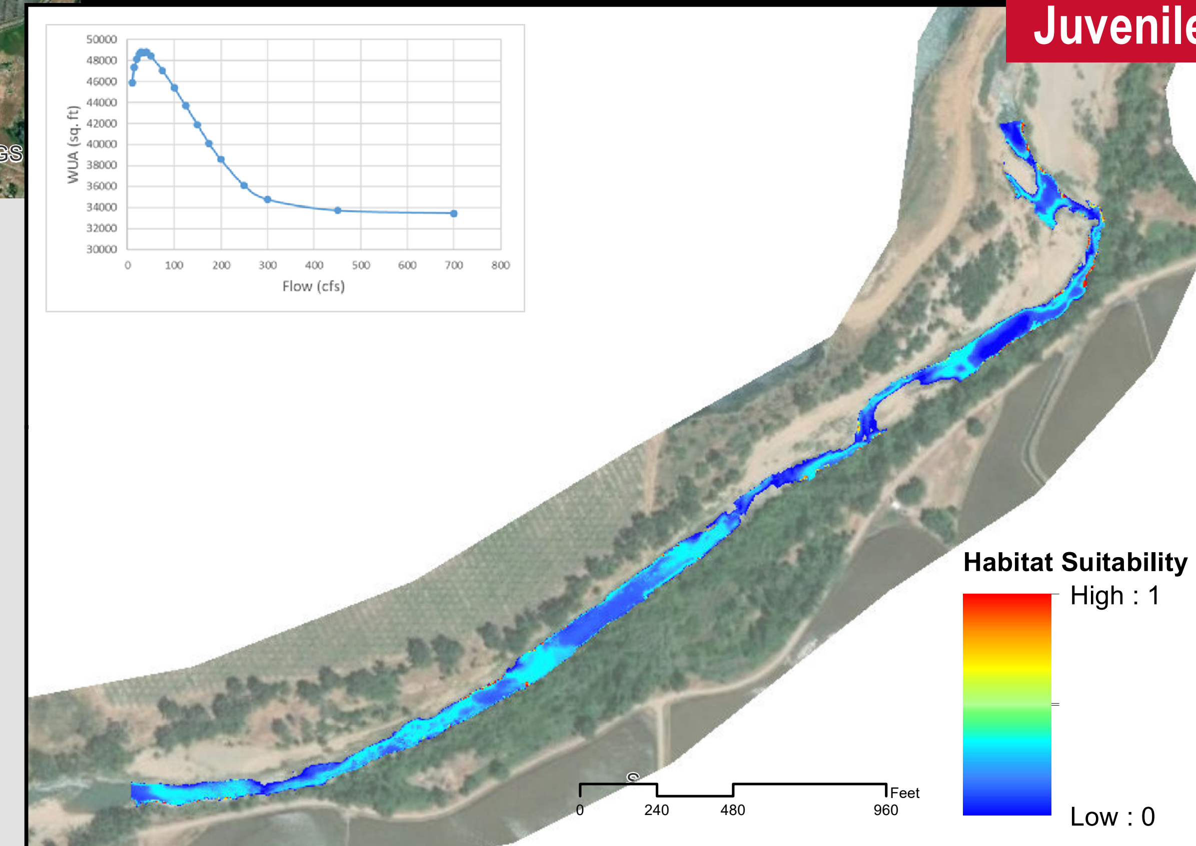
Fall-Run Chinook Salmon

Upstream Study Site 30 cfs

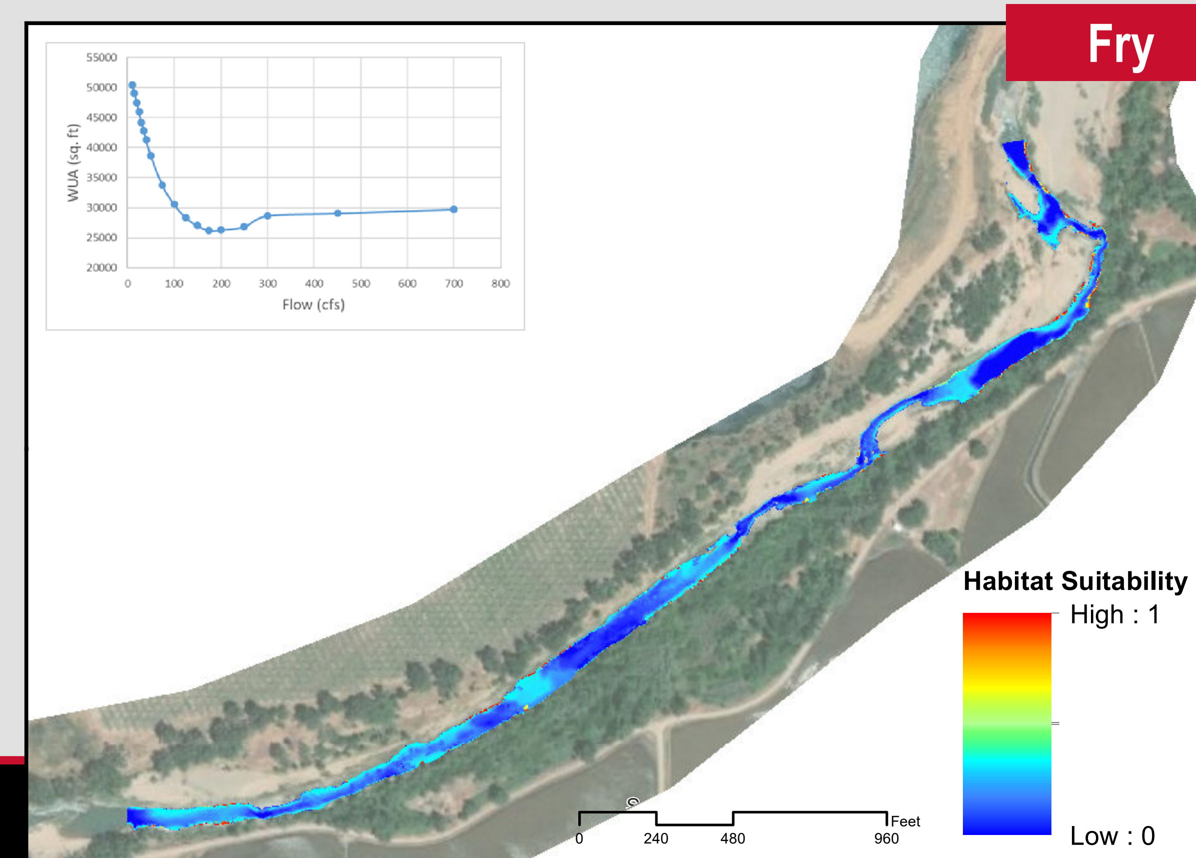
Spawning



Juvenile



Fry

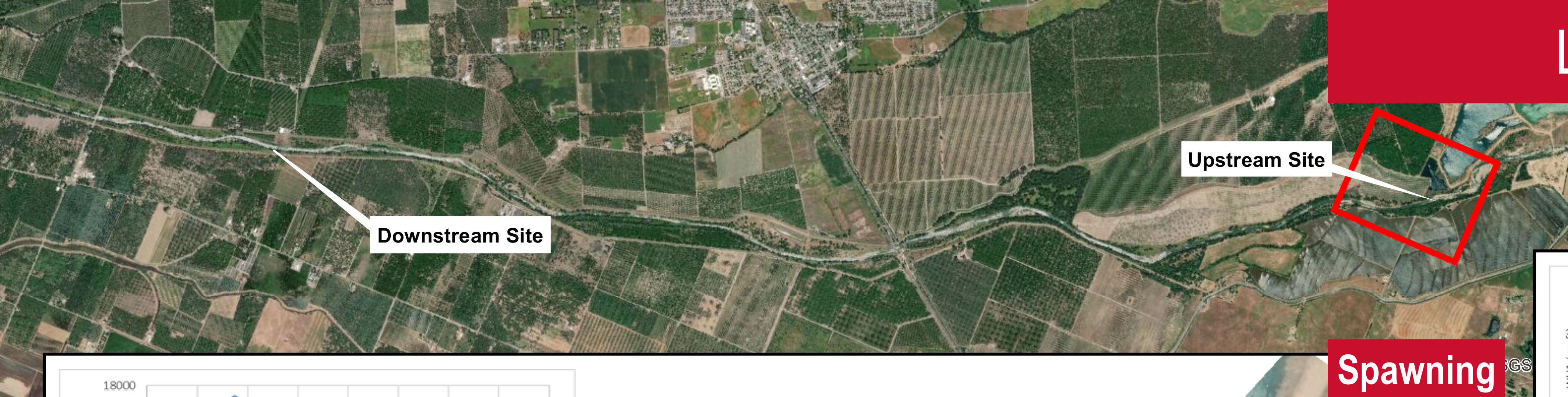


Lower Bear River - Instream Flow Study

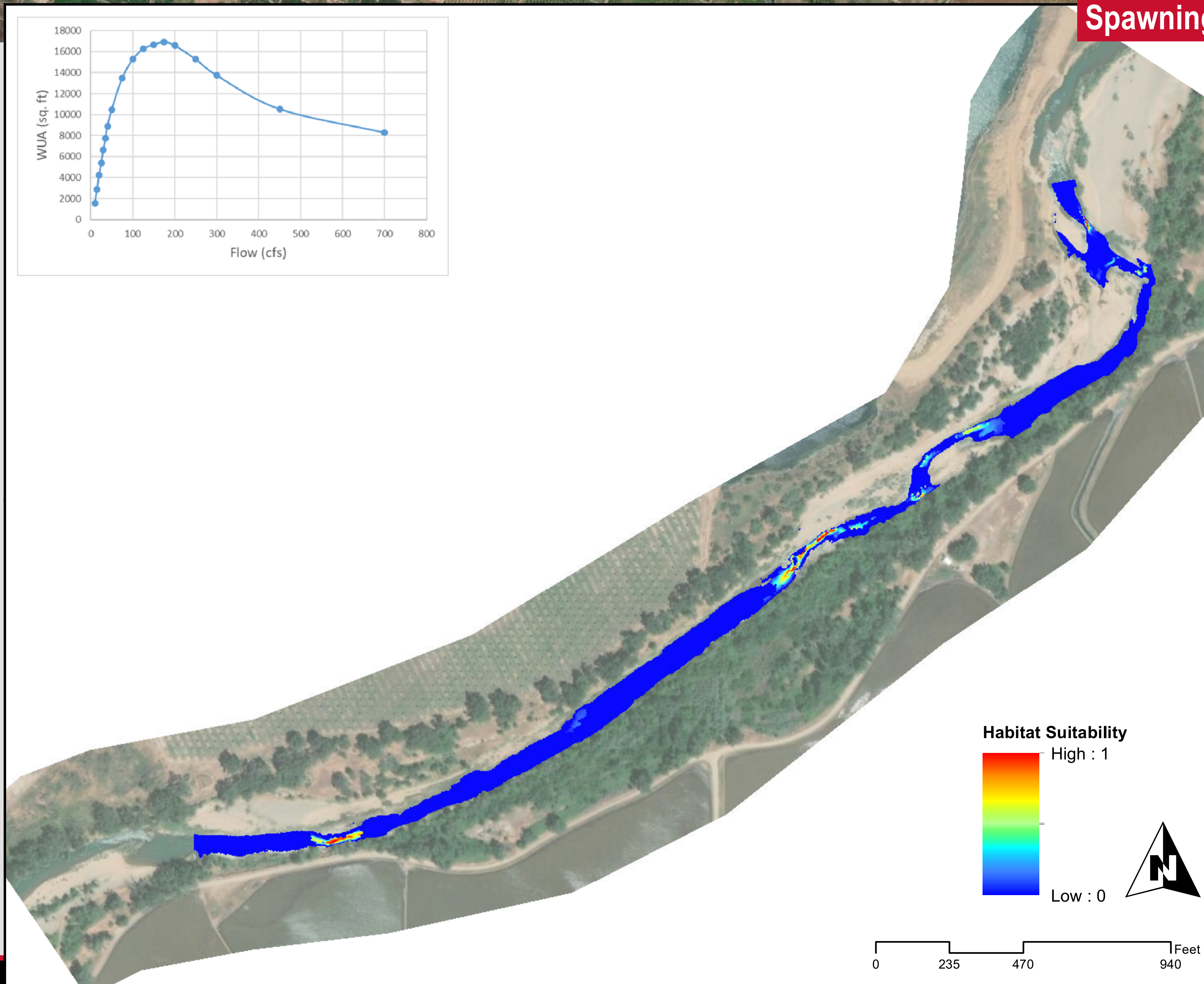
SSWD HDR

Fall-Run Chinook Salmon

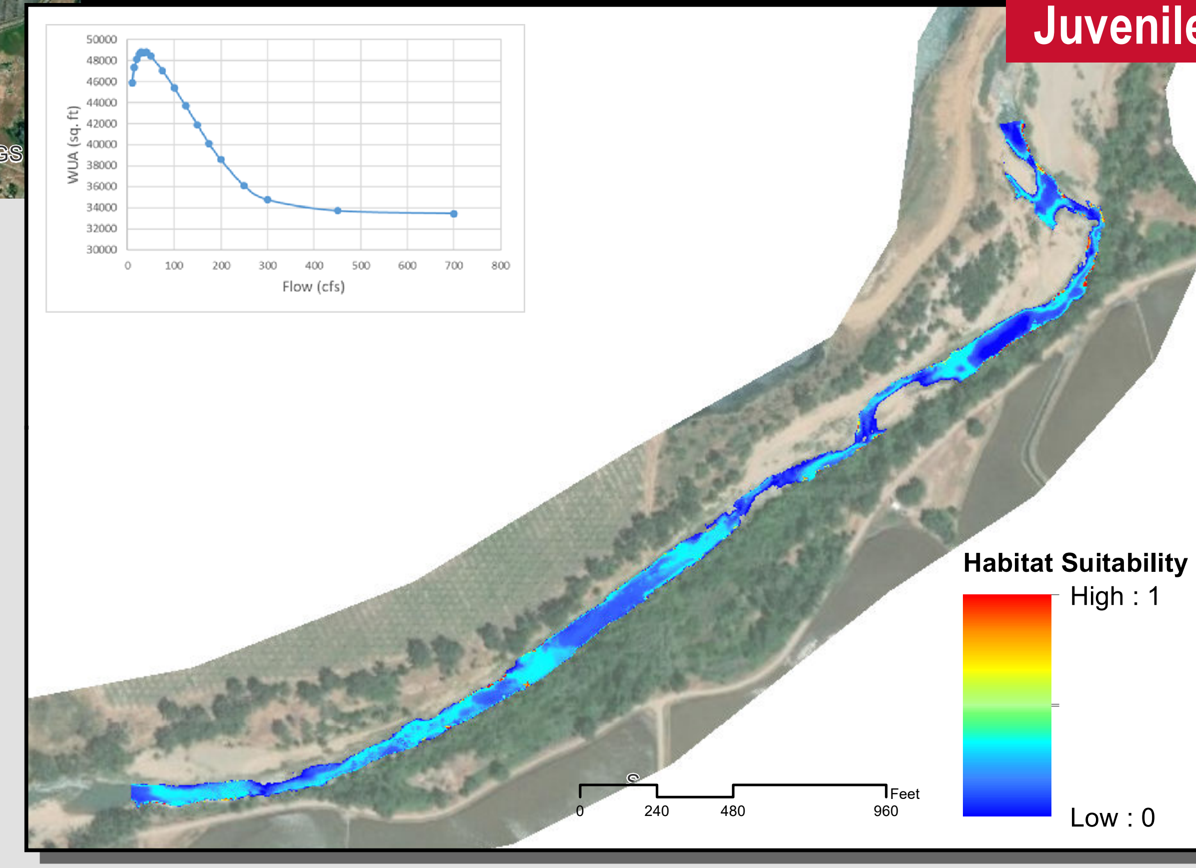
Upstream Study Site 35 cfs



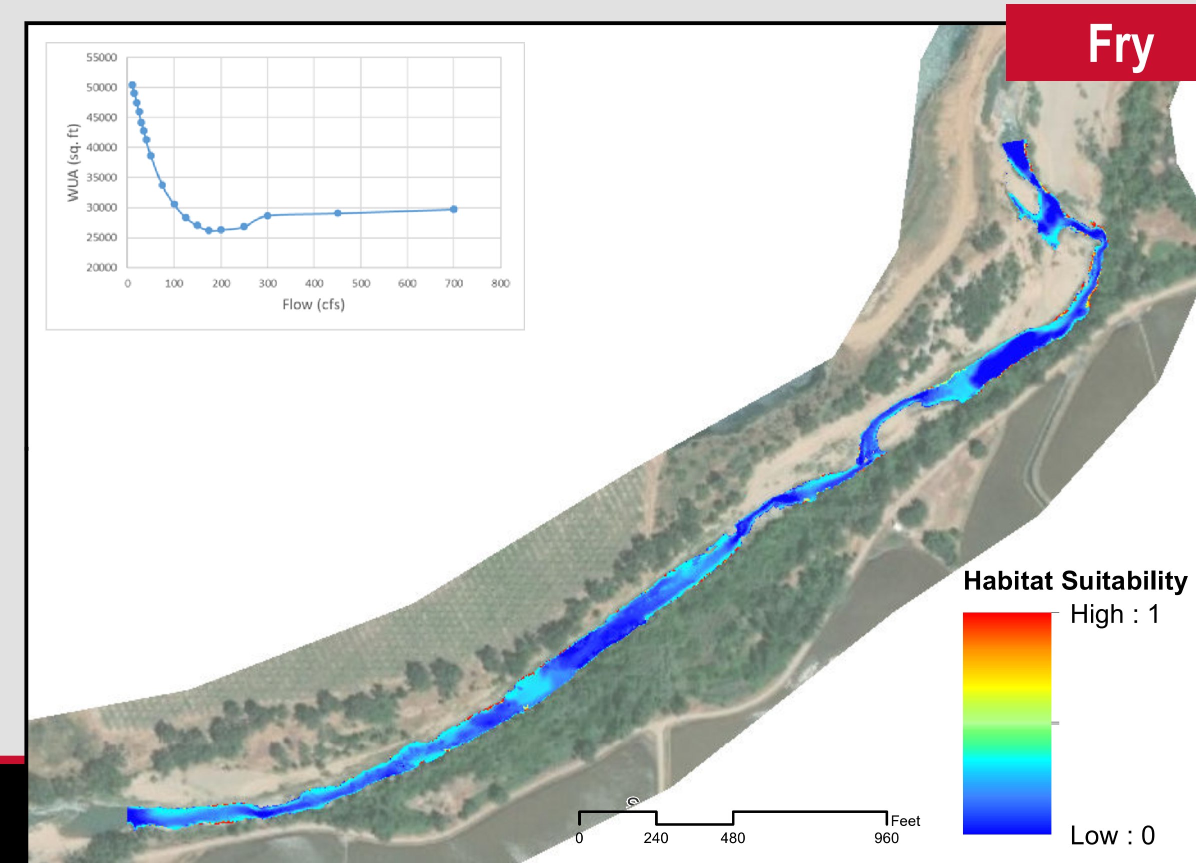
Spawning



Juvenile



Fry

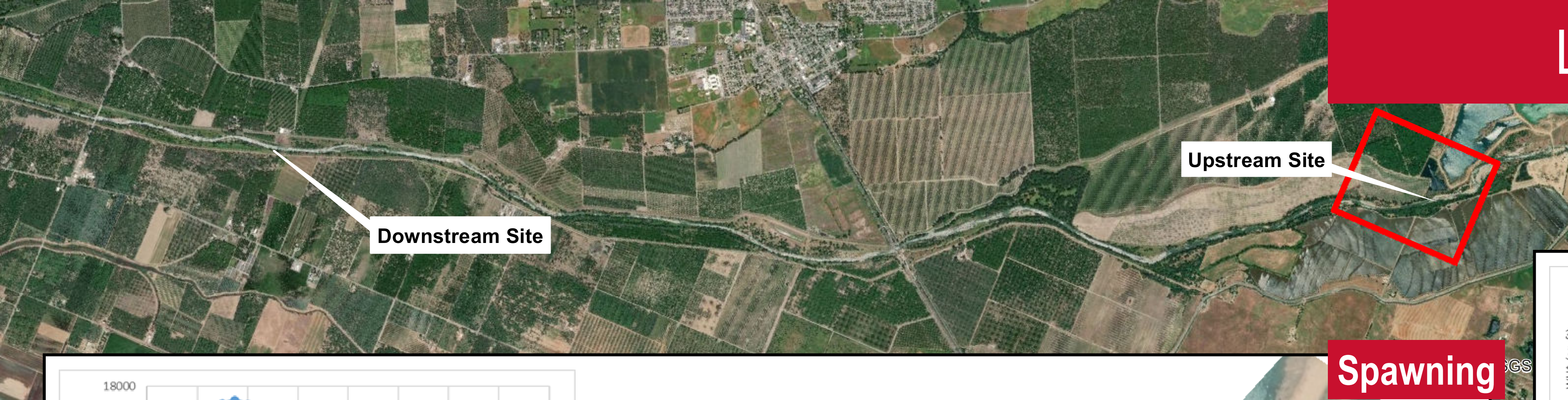


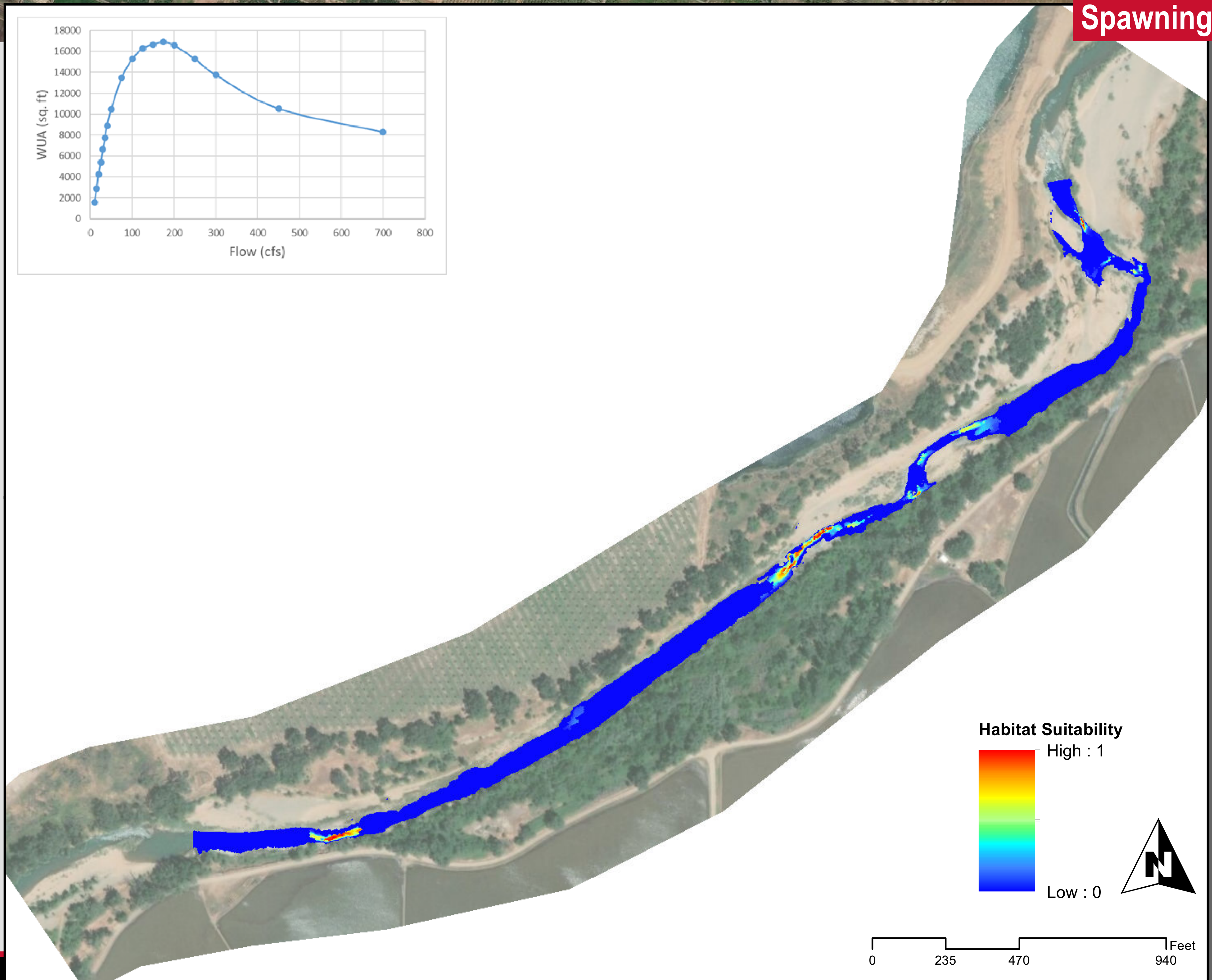
Lower Bear River - Instream Flow Study

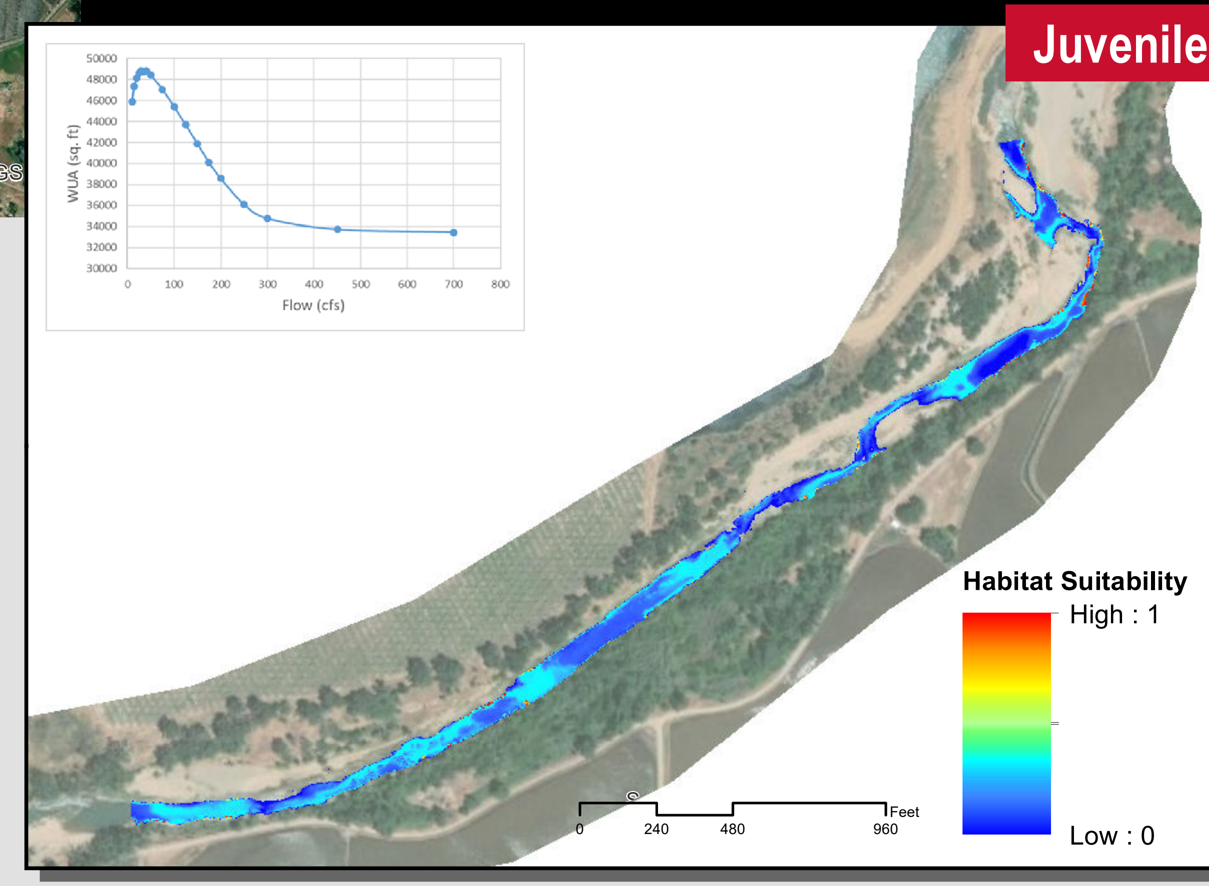
SSWD HDR

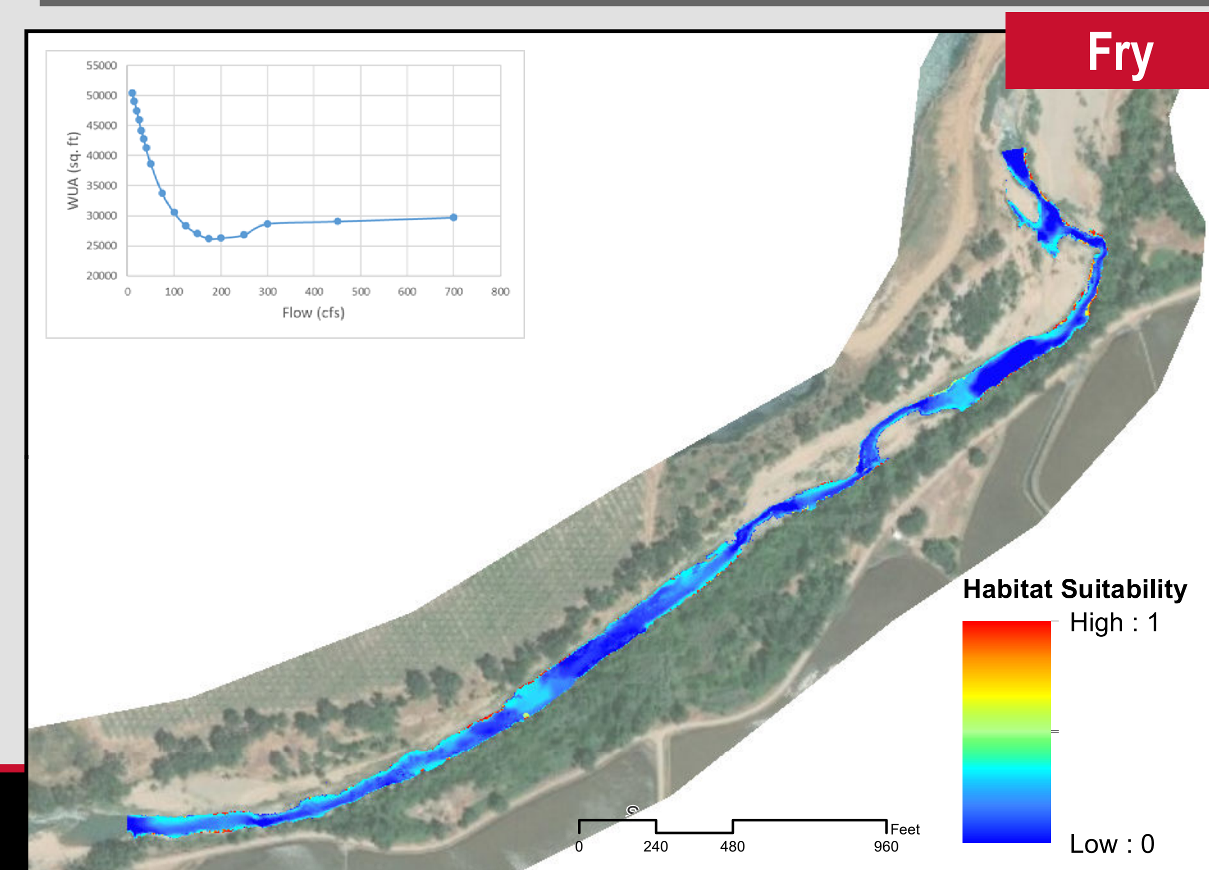
Fall-Run Chinook Salmon

Upstream Study Site 40 cfs









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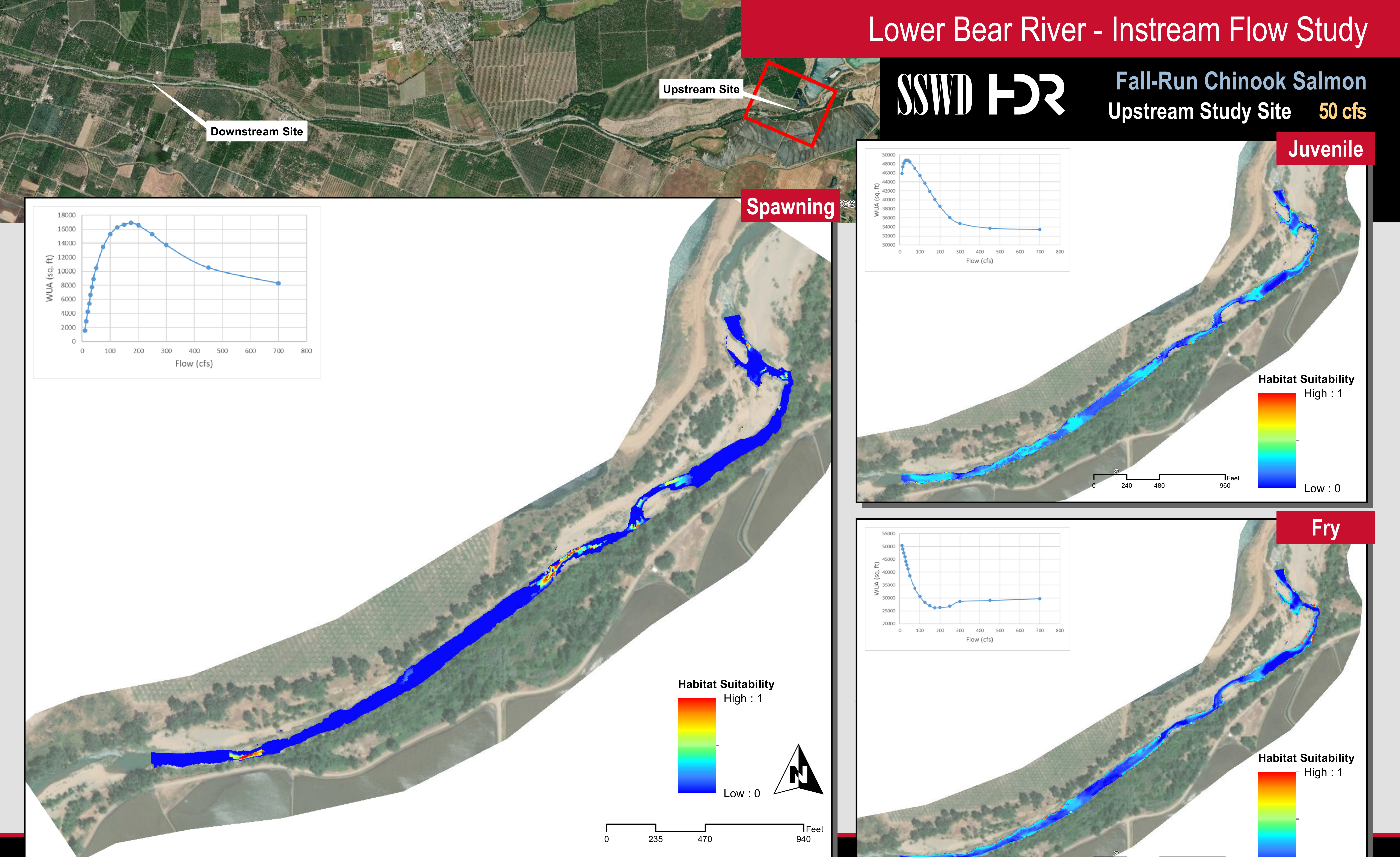
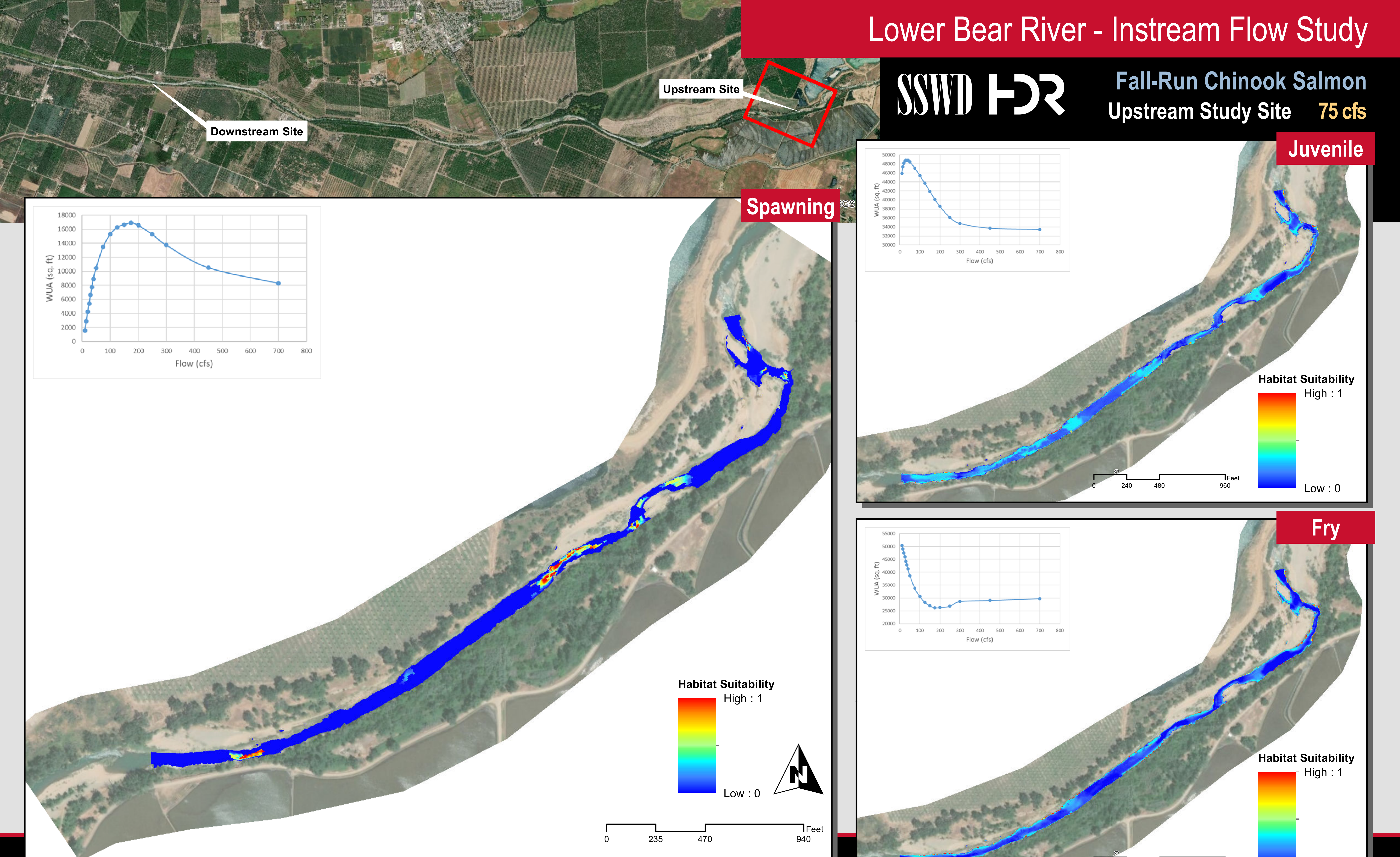

Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Upstream Study Site
50 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
N
0
235
470
940
Feet
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet

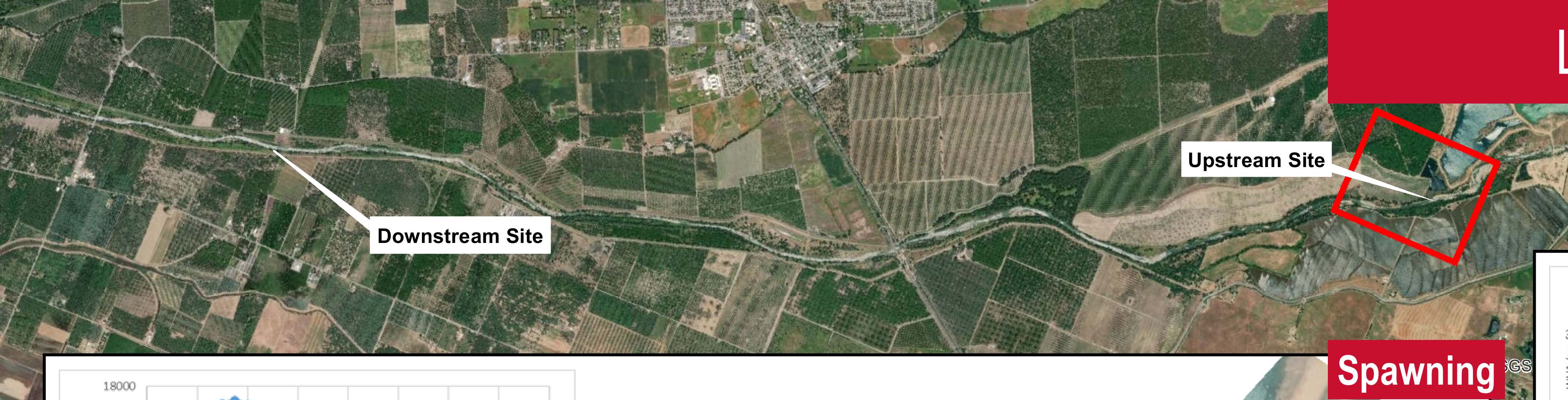


PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

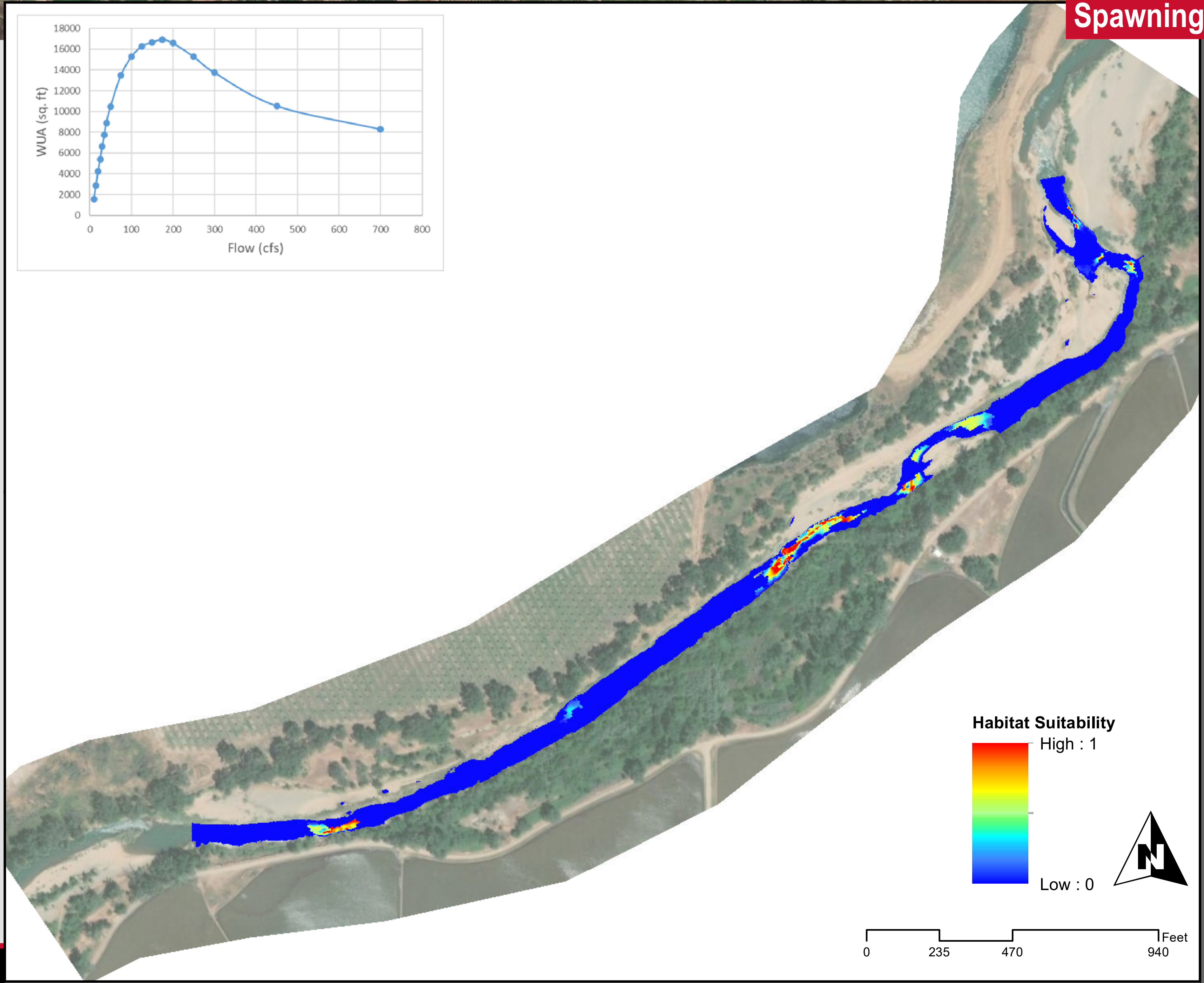
Lower Bear River - Instream Flow Study

Fall-Run Chinook Salmon

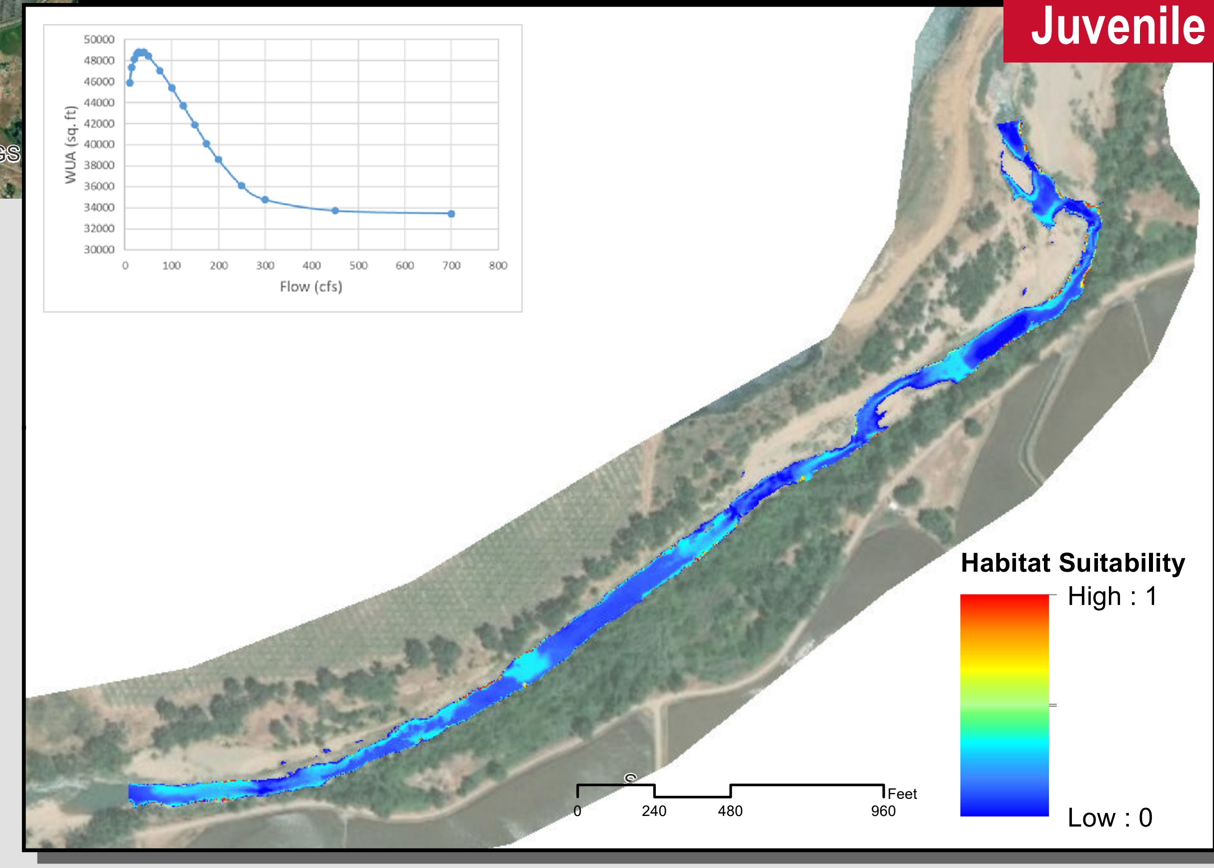
Upstream Study Site 100 cfs



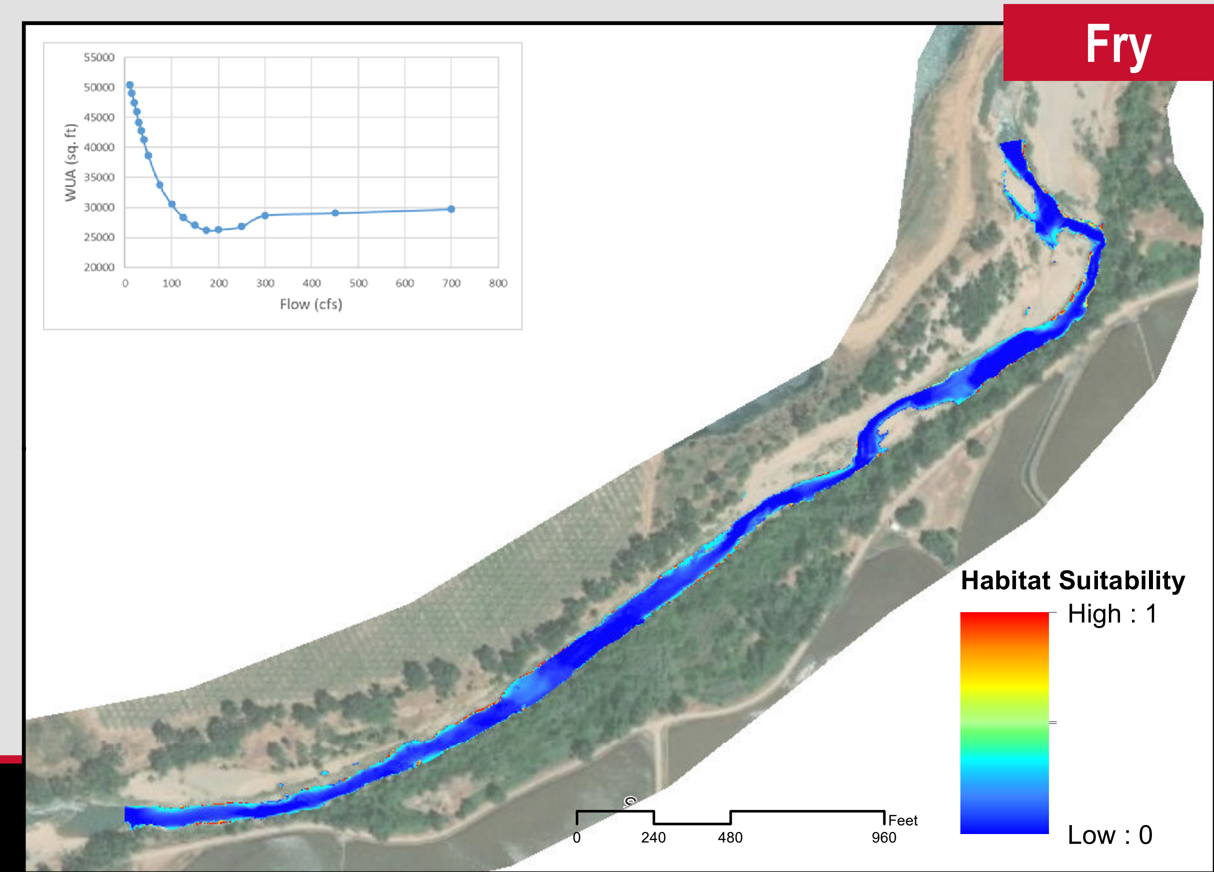
Spawning



Juvenile



Fry



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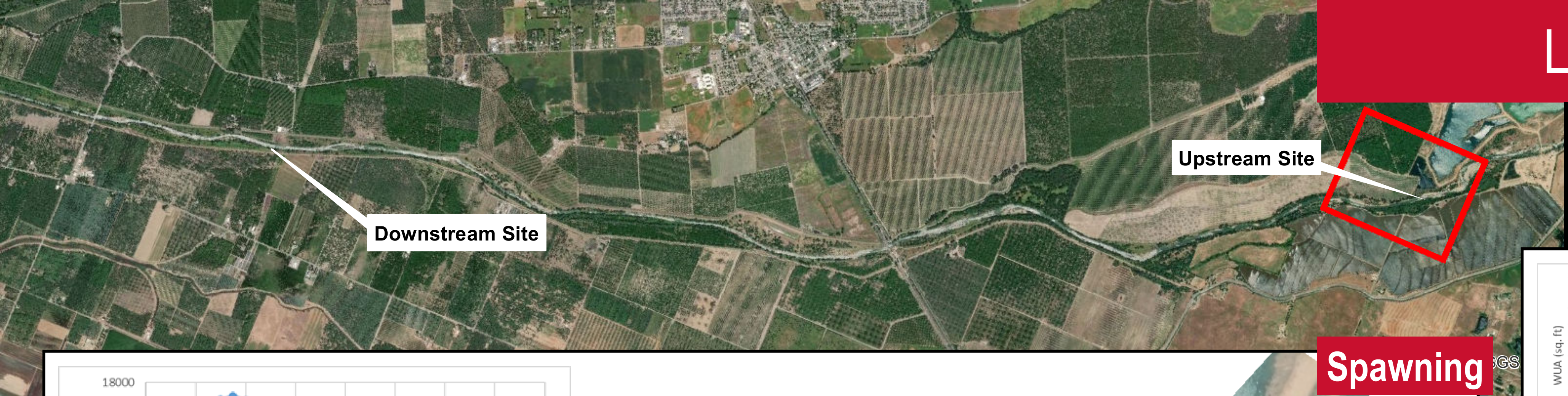
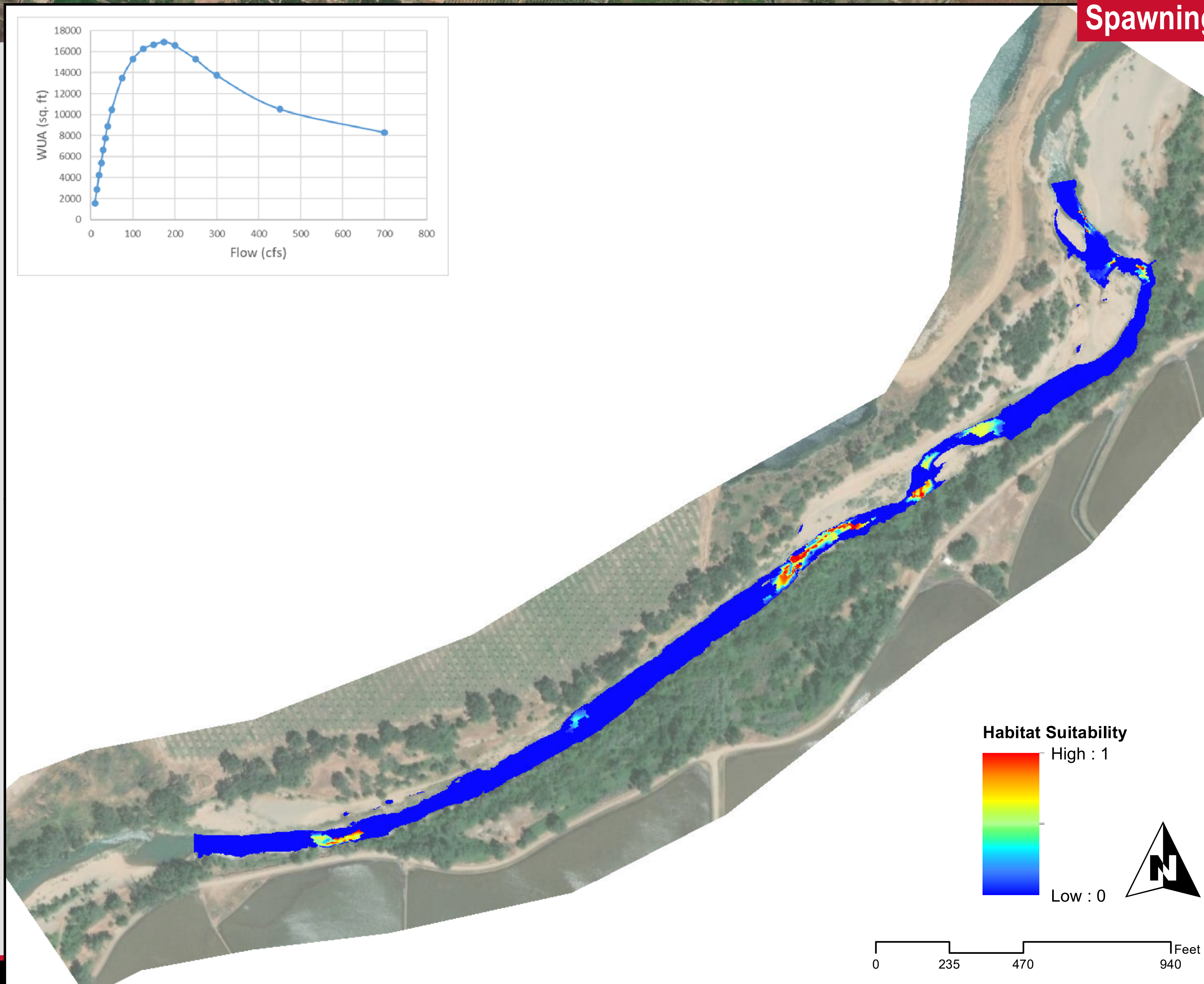
Lower Bear River - Instream Flow Study

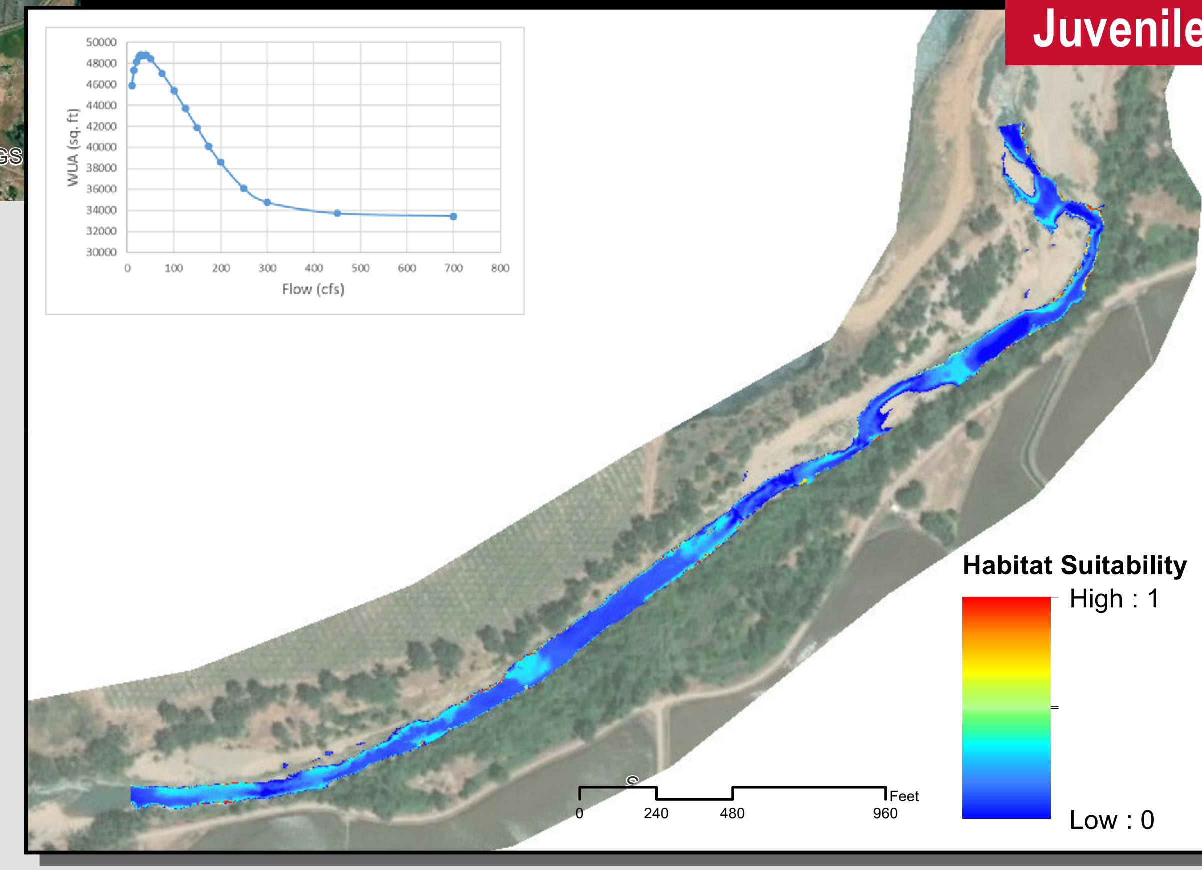
SSWD HDR

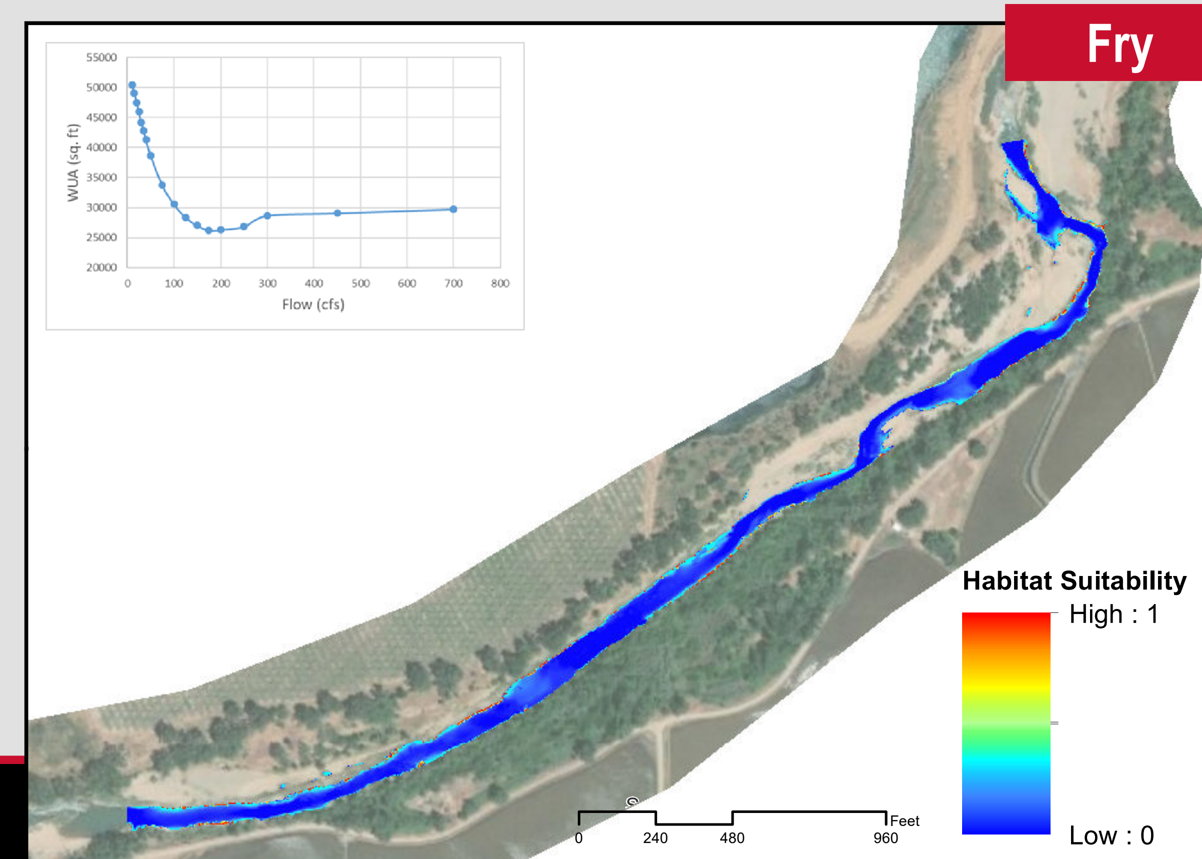
Fall-Run Chinook Salmon

Upstream Study Site 125 cfs









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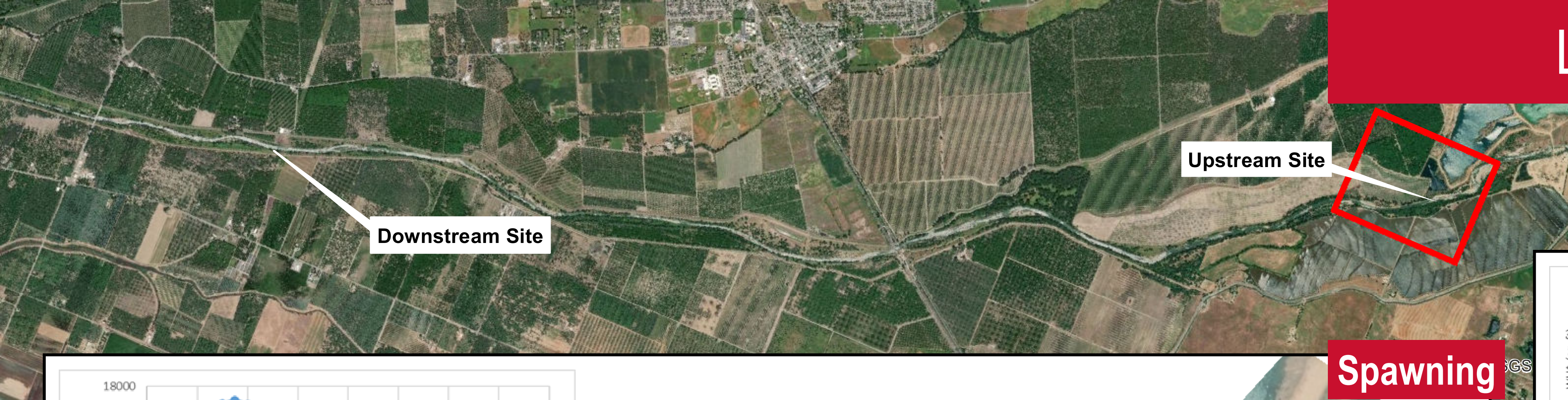
Lower Bear River - Instream Flow Study

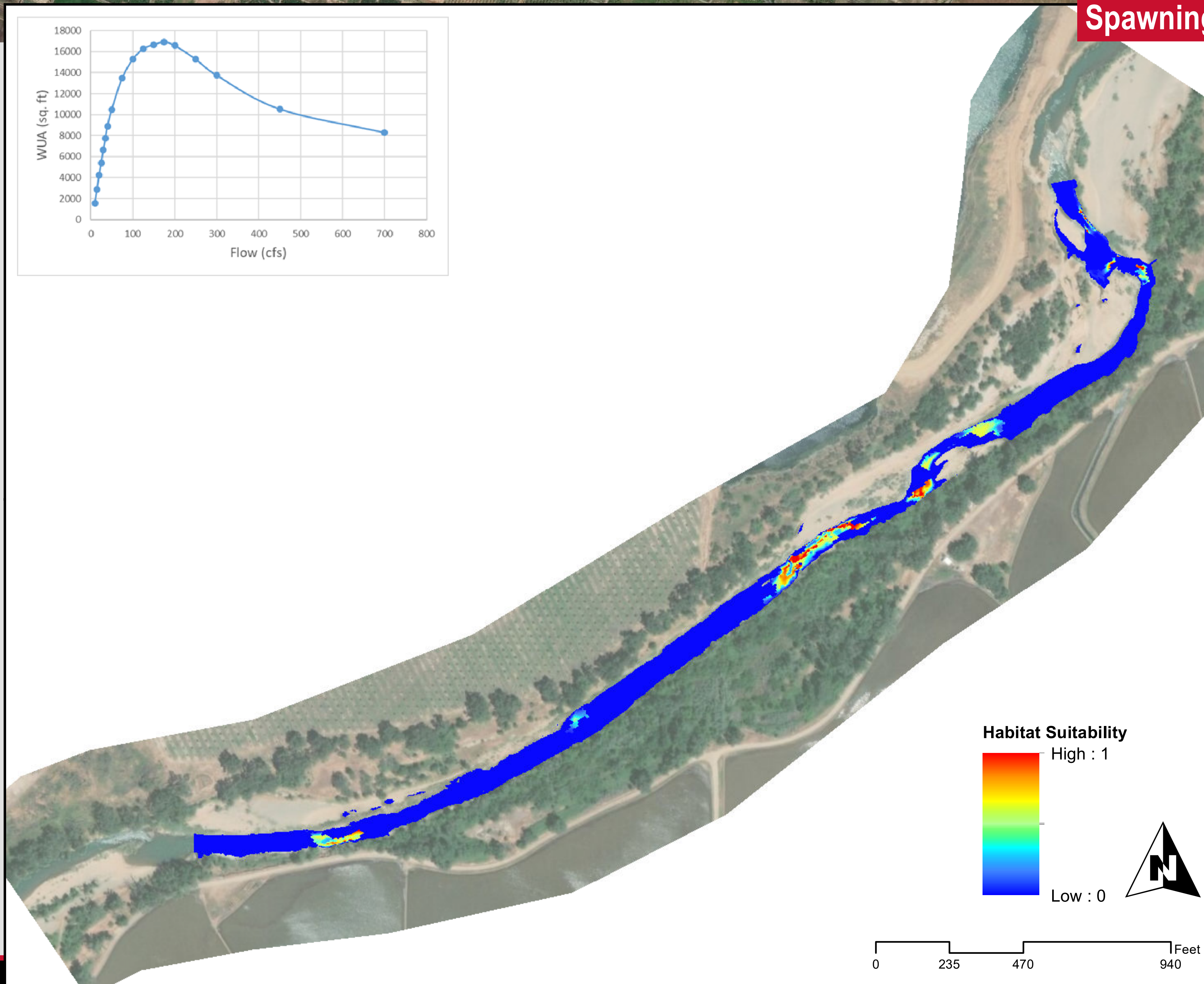
SSWD HDR

Fall-Run Chinook Salmon

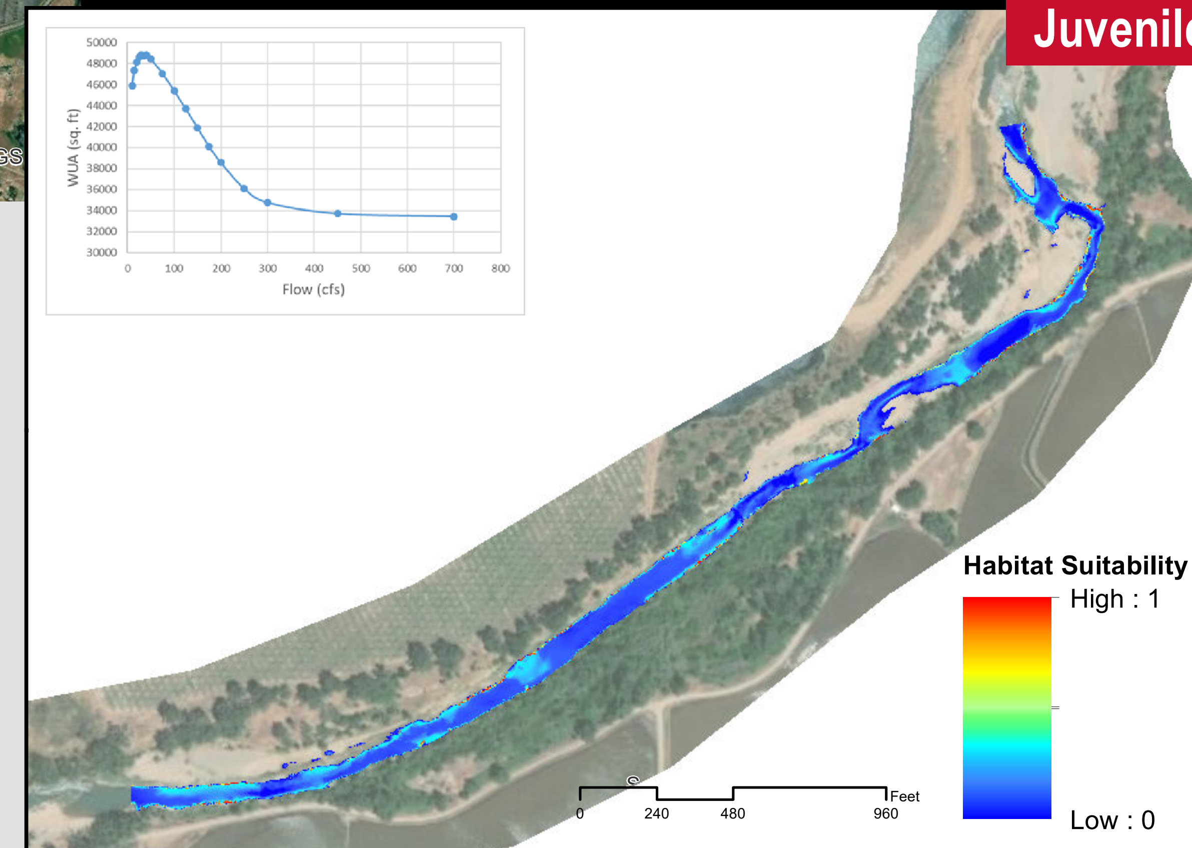
Upstream Study Site 150 cfs



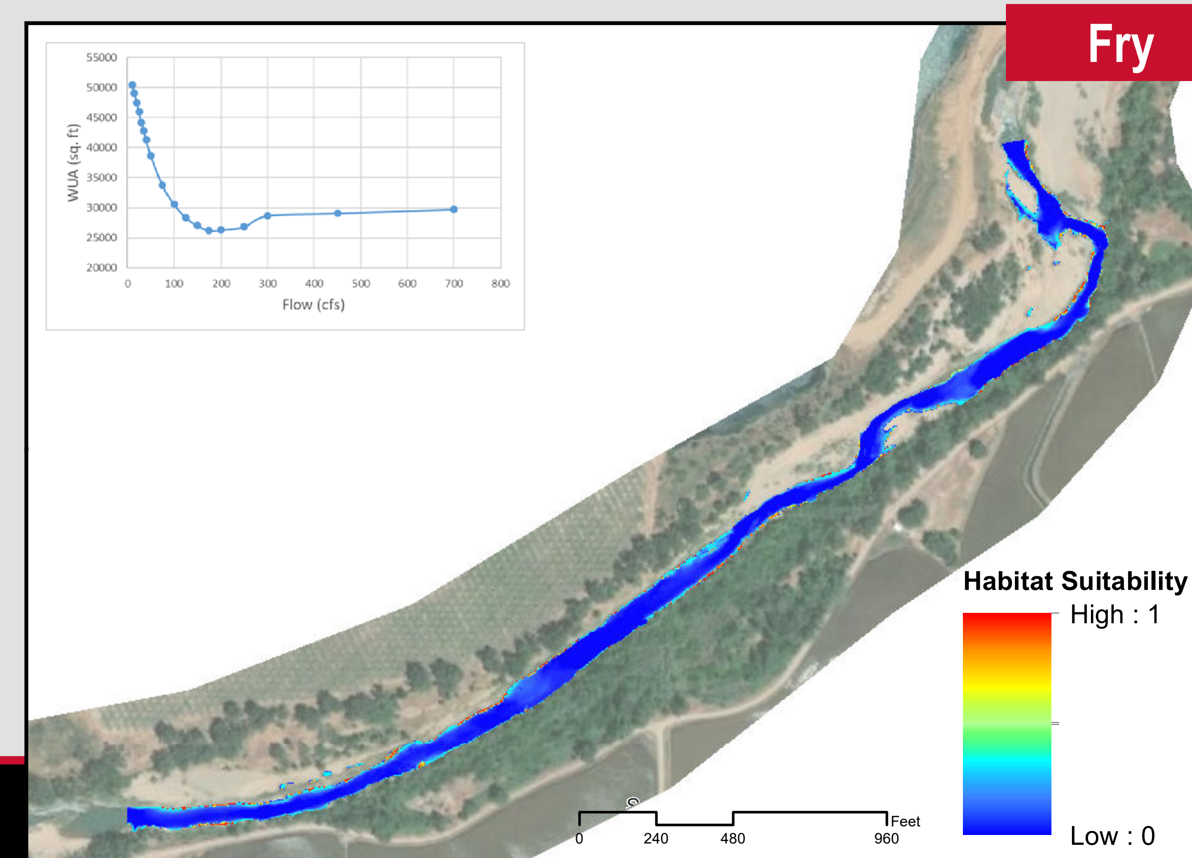
Spawning



Juvenile



Fry

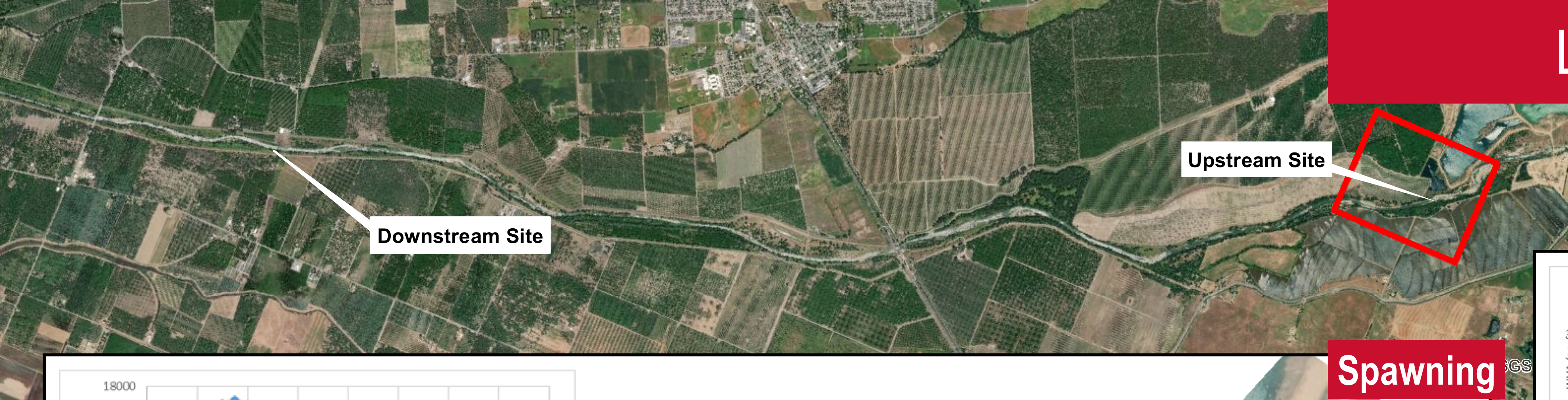


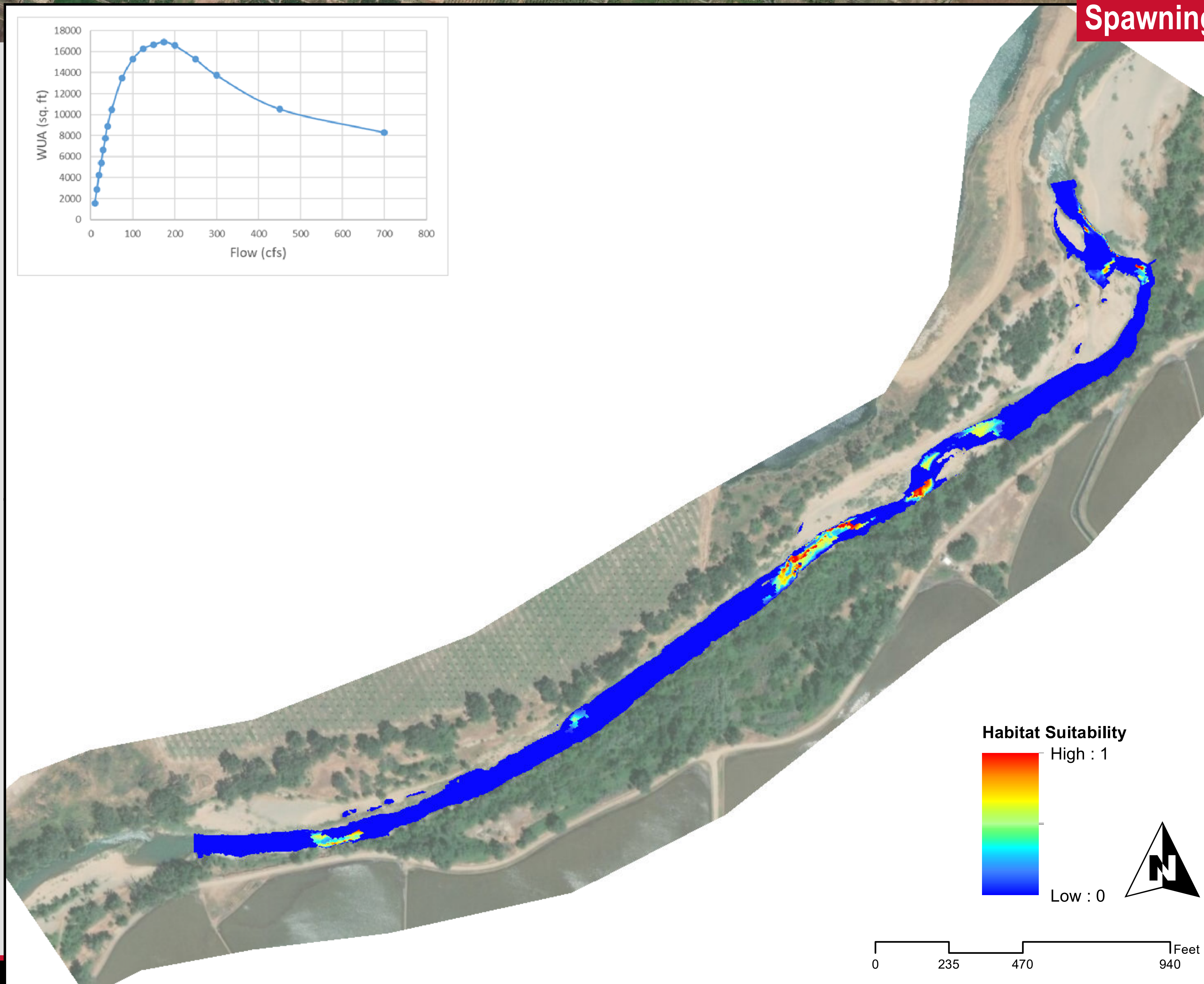
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

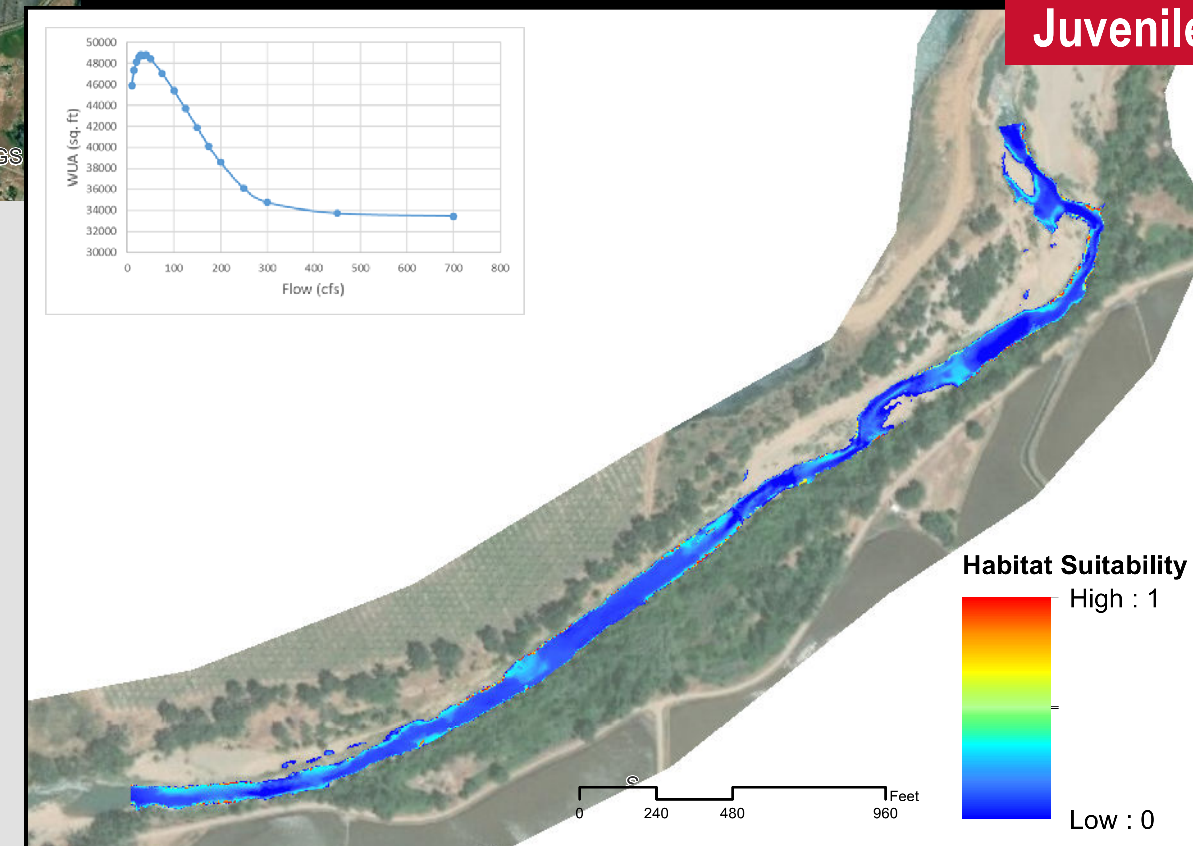
Lower Bear River - Instream Flow Study

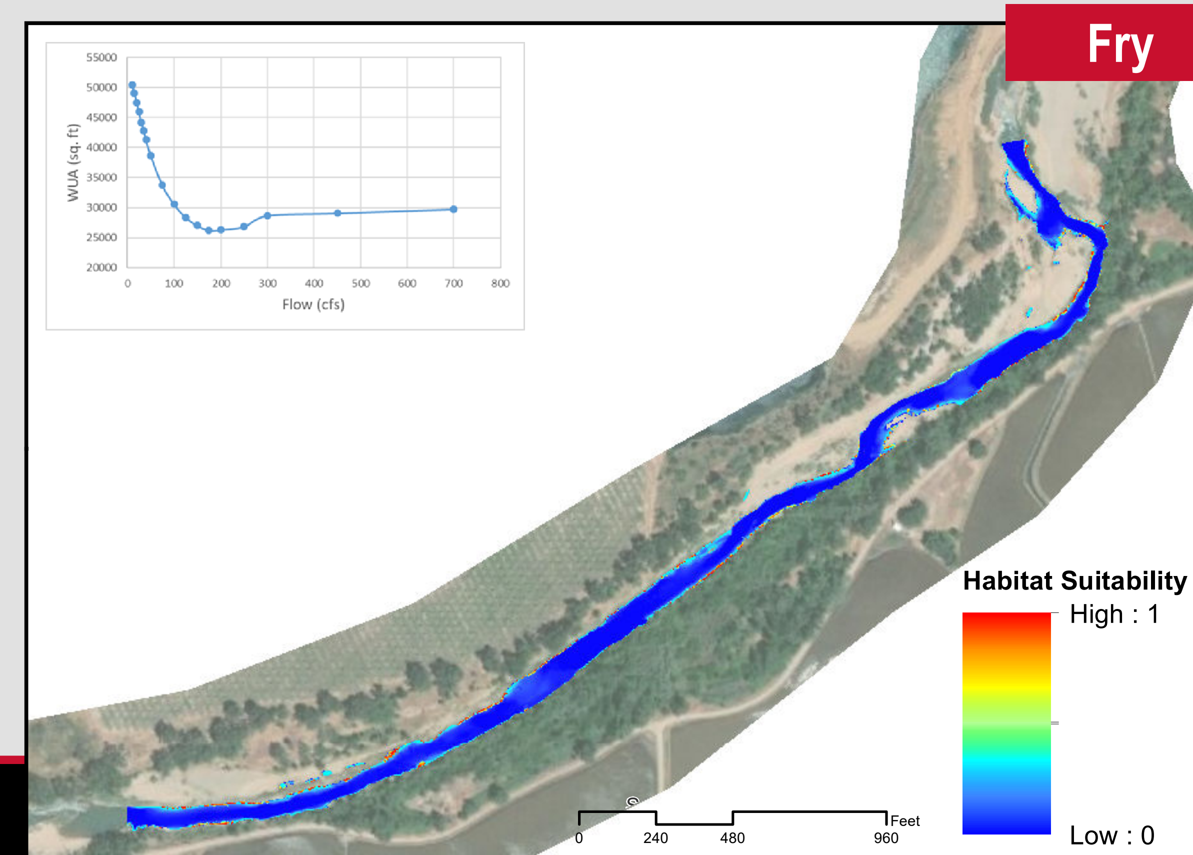
SSWD HDR

Fall-Run Chinook Salmon
Upstream Study Site 175 cfs









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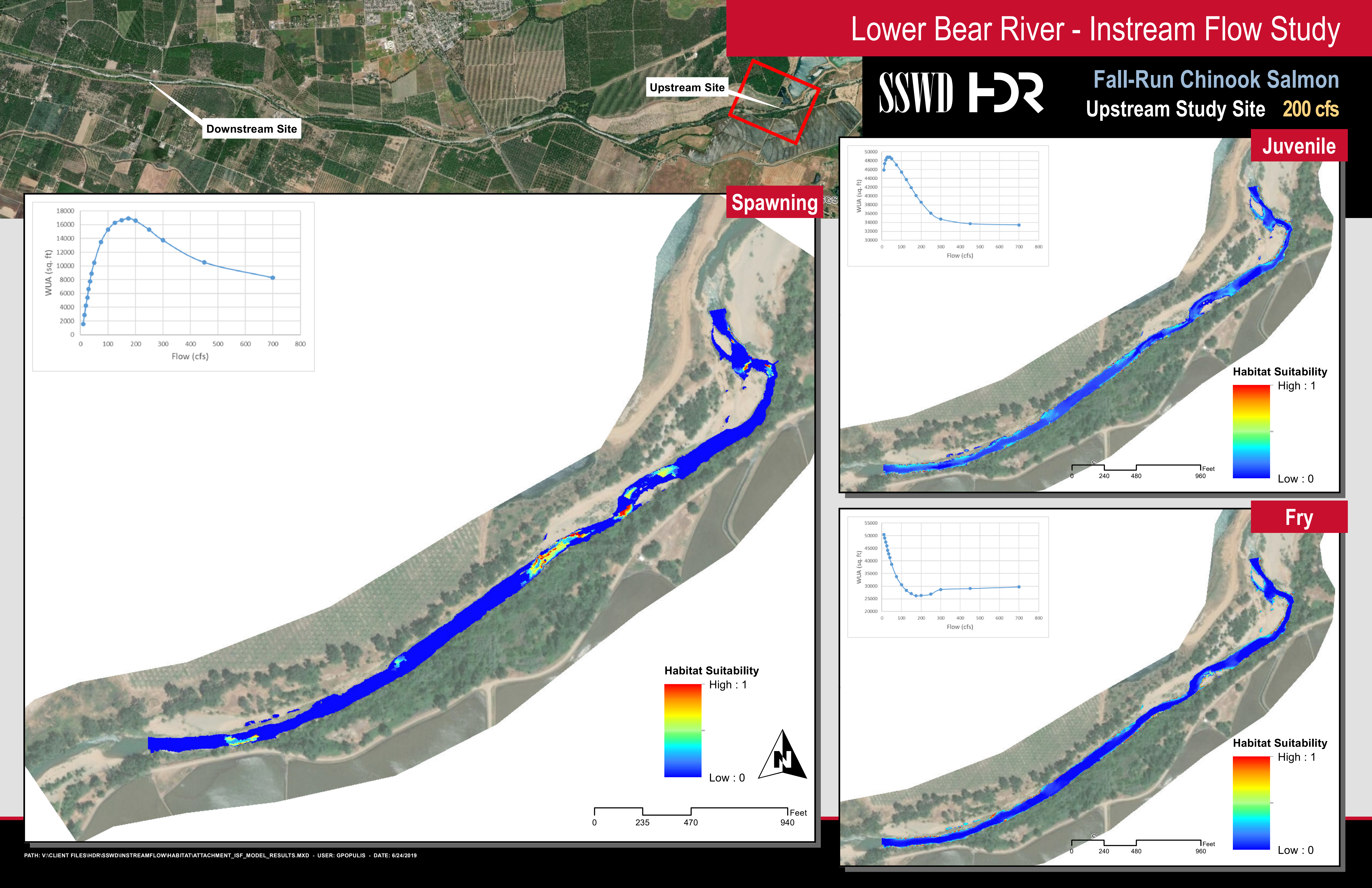
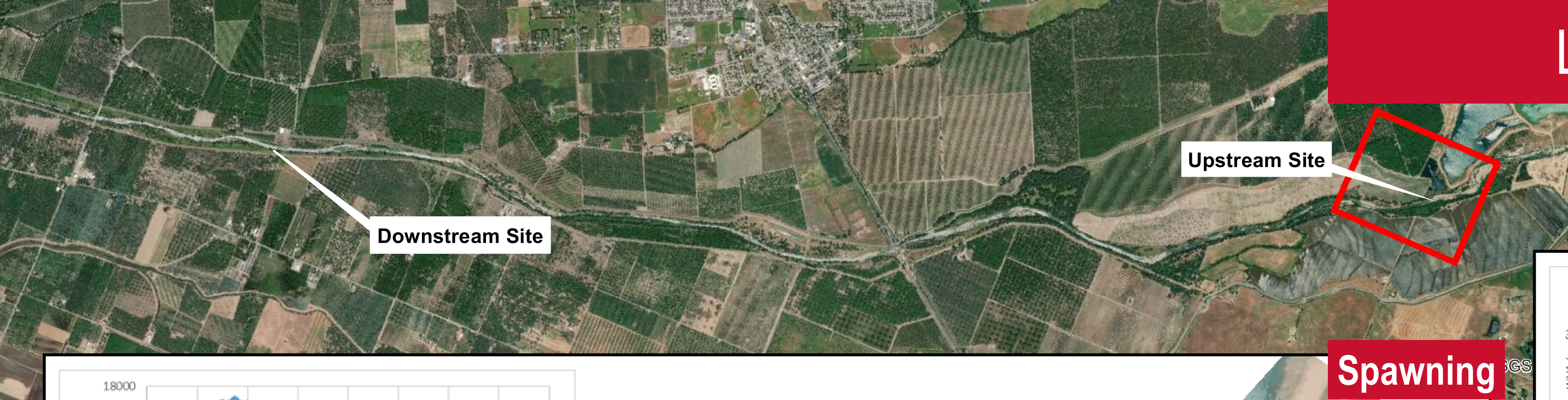


Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Upstream Study Site 200 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 235 470 940 Feet
N
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 240 480 960 Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 240 480 960 Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

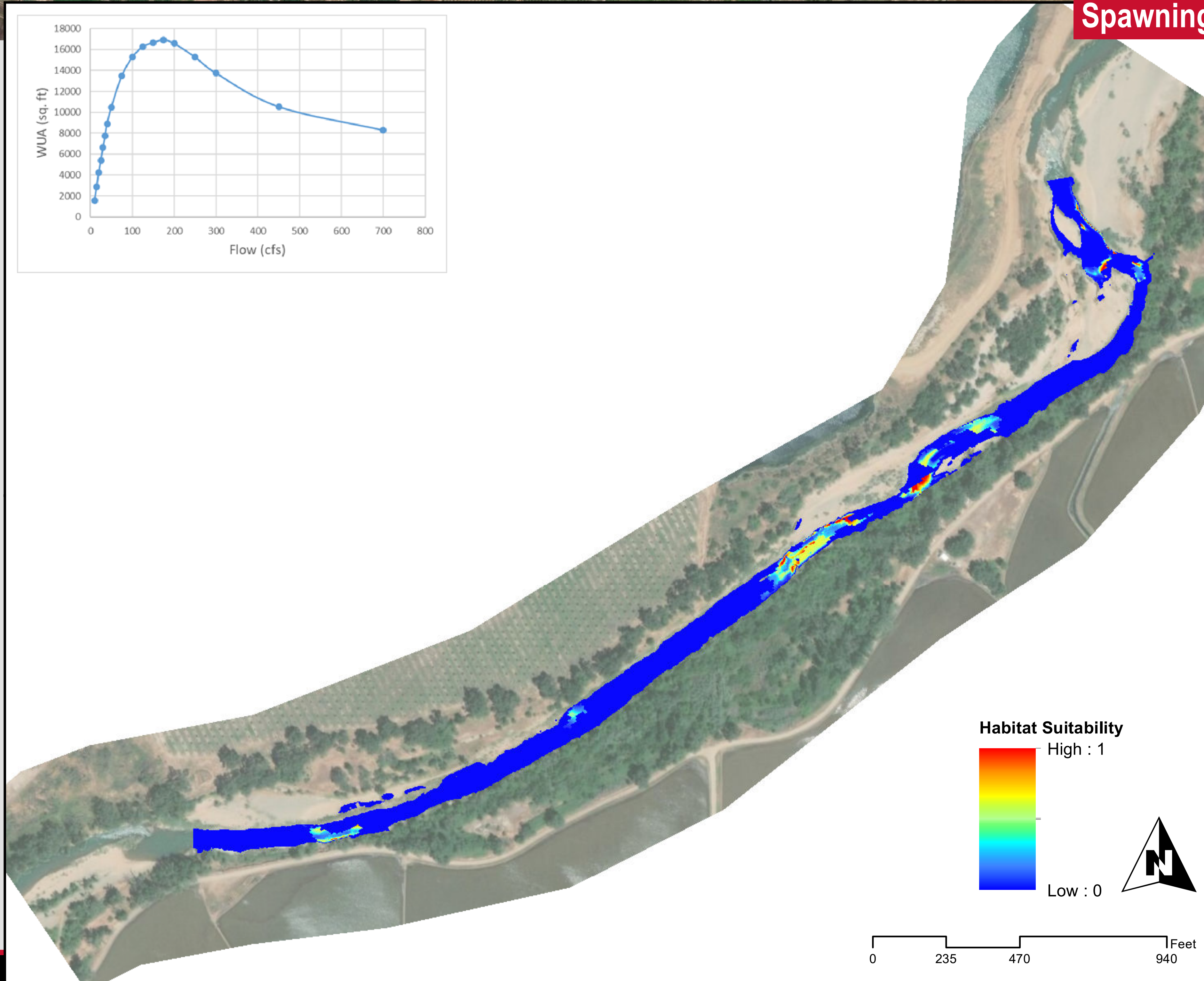
Lower Bear River - Instream Flow Study



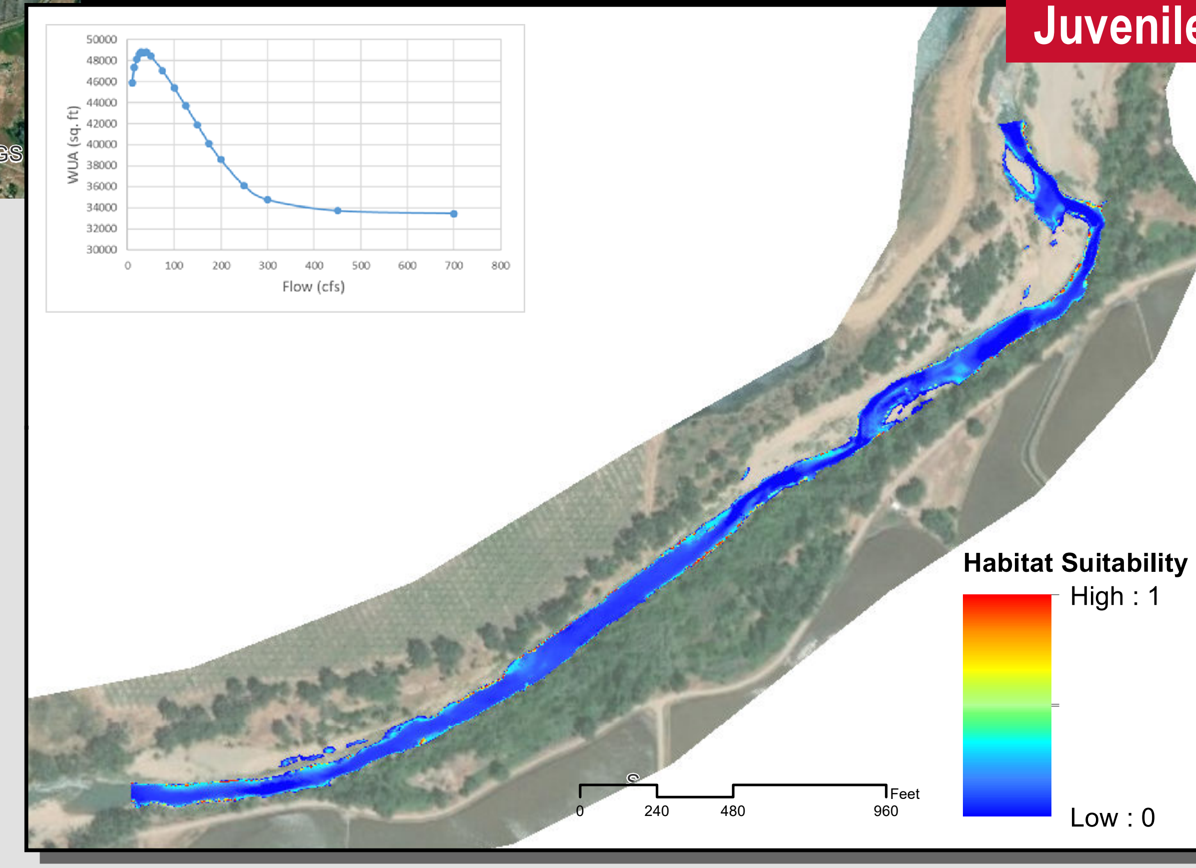
Fall-Run Chinook Salmon

Upstream Study Site 250 cfs

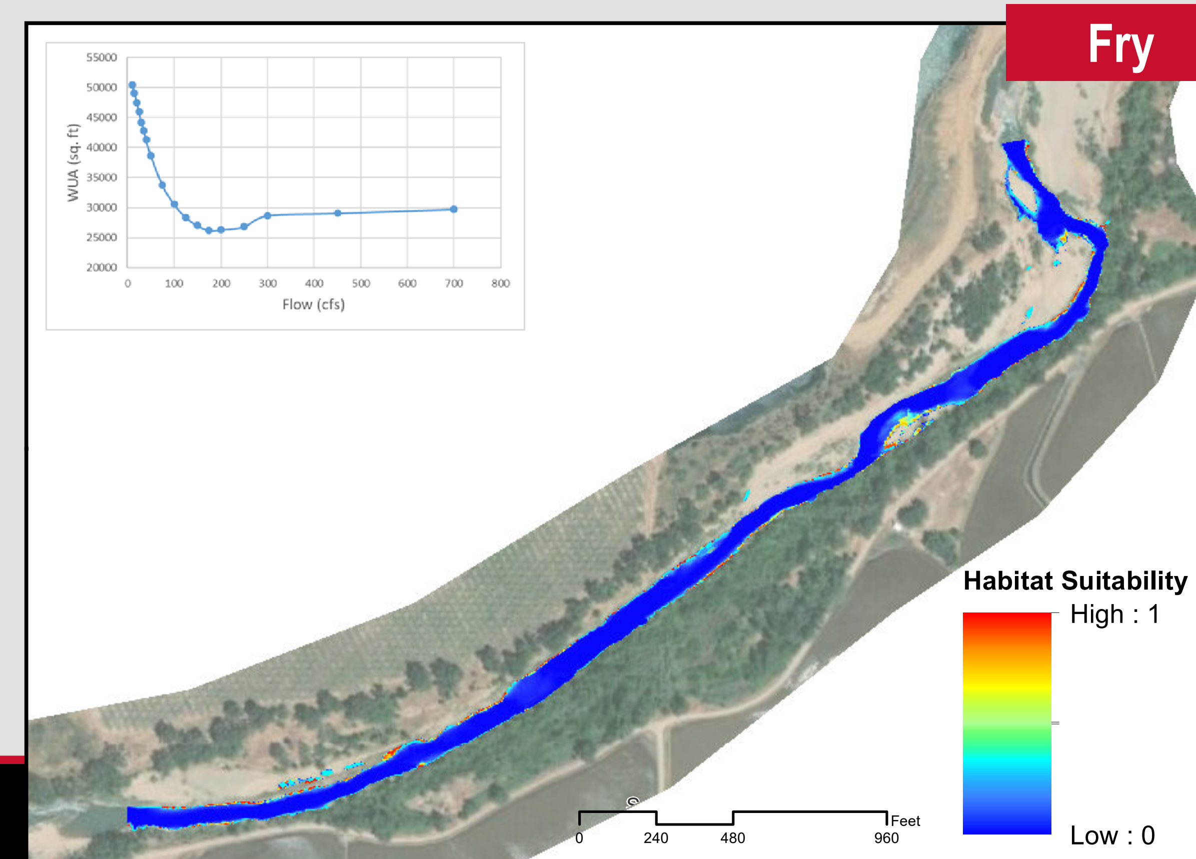
Spawning



Juvenile



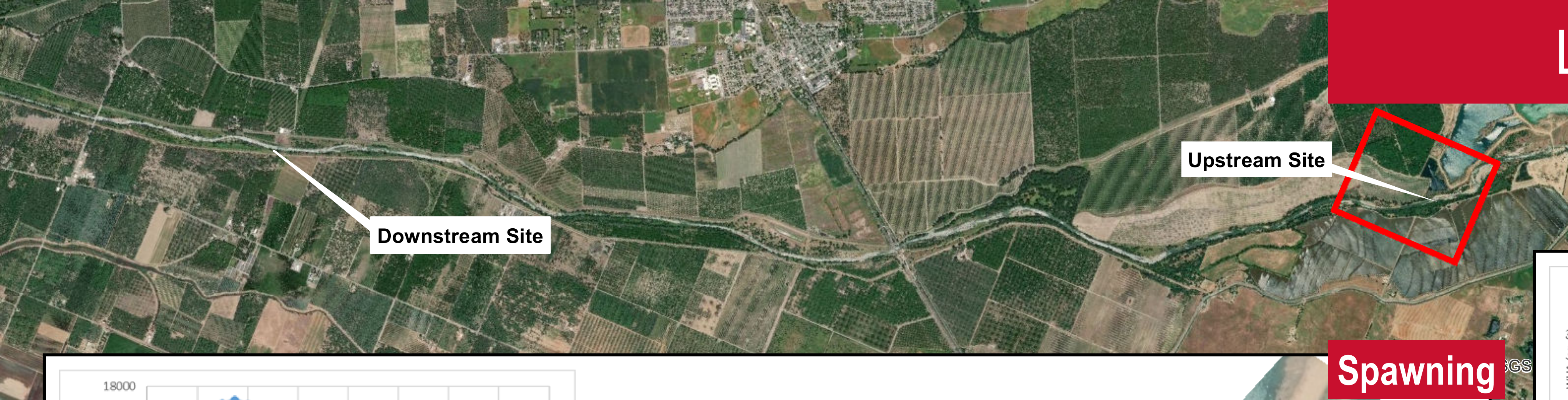
Fry



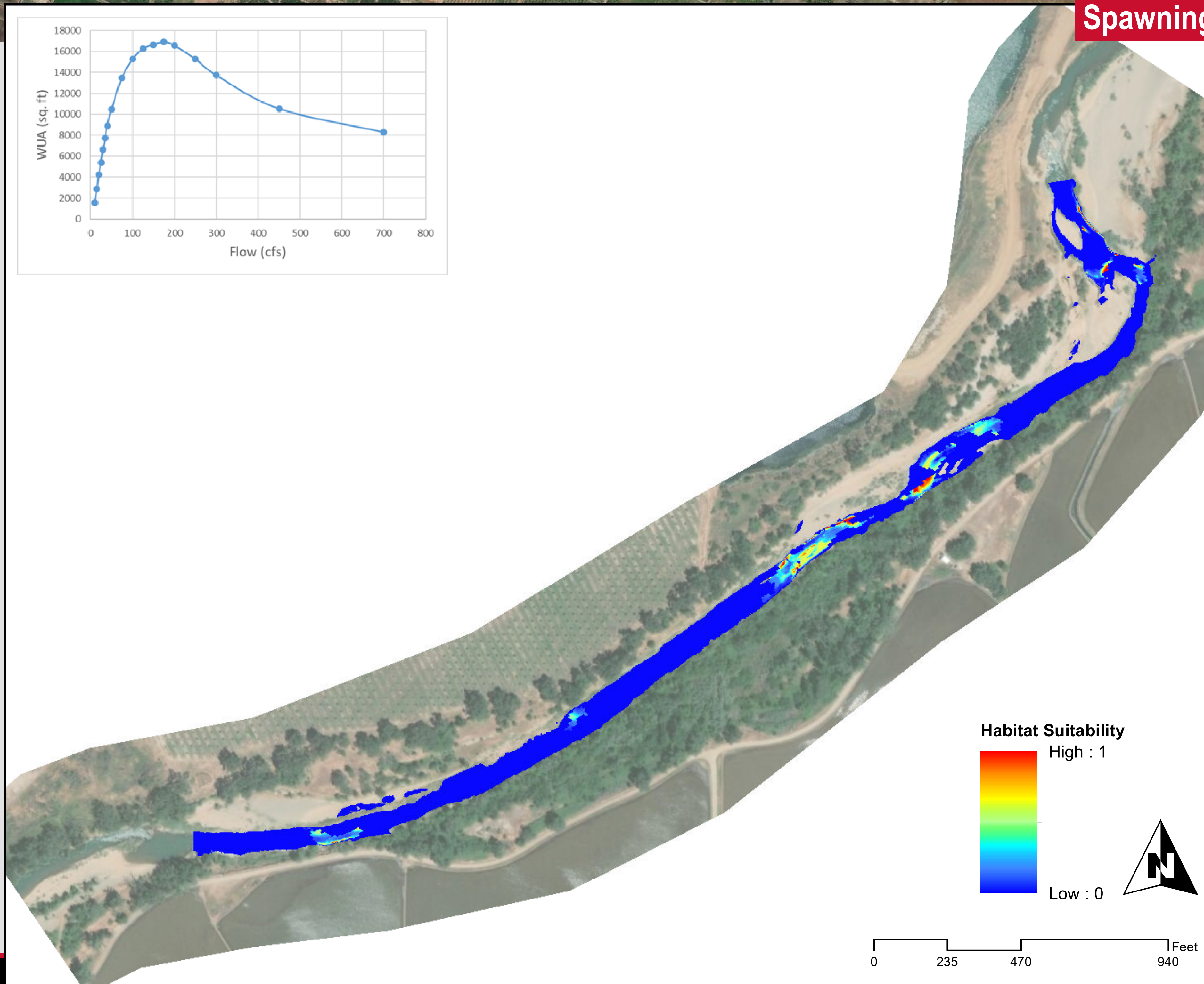
Lower Bear River - Instream Flow Study

Fall-Run Chinook Salmon

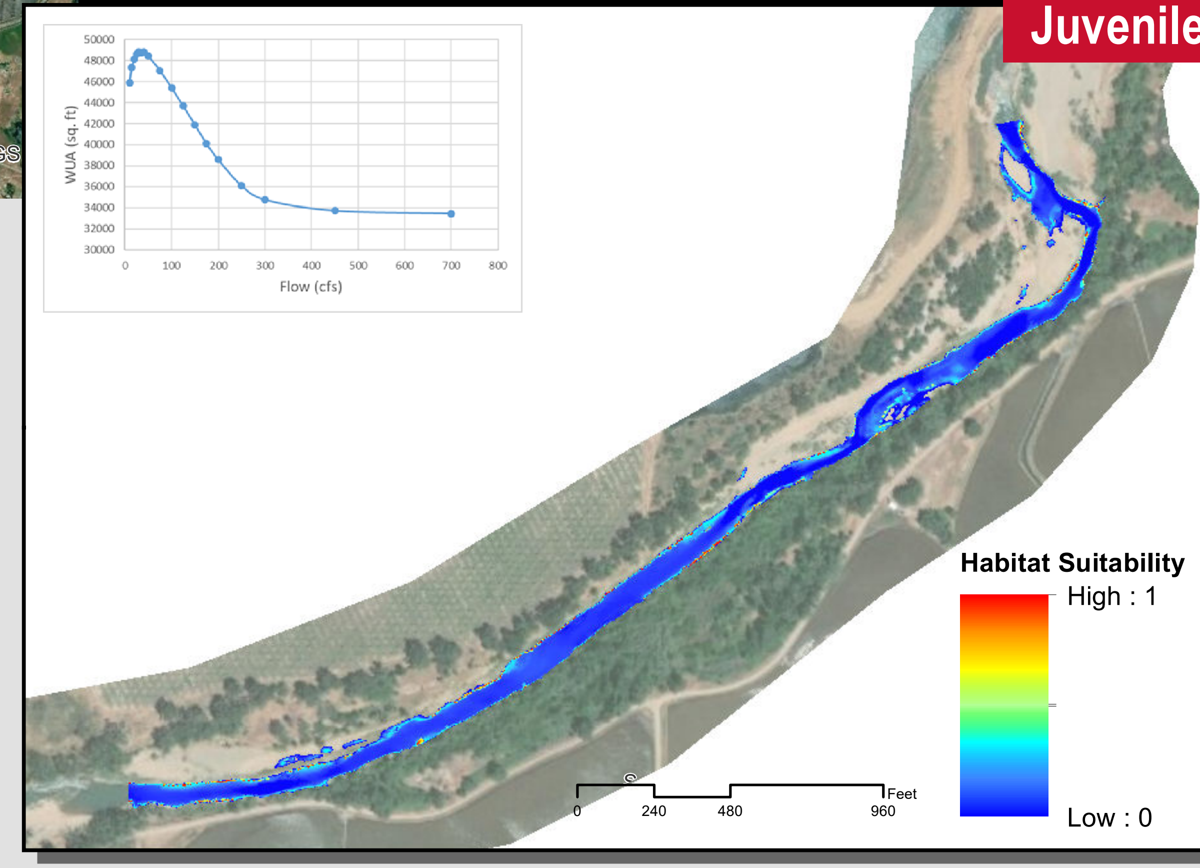
Upstream Study Site 300 cfs



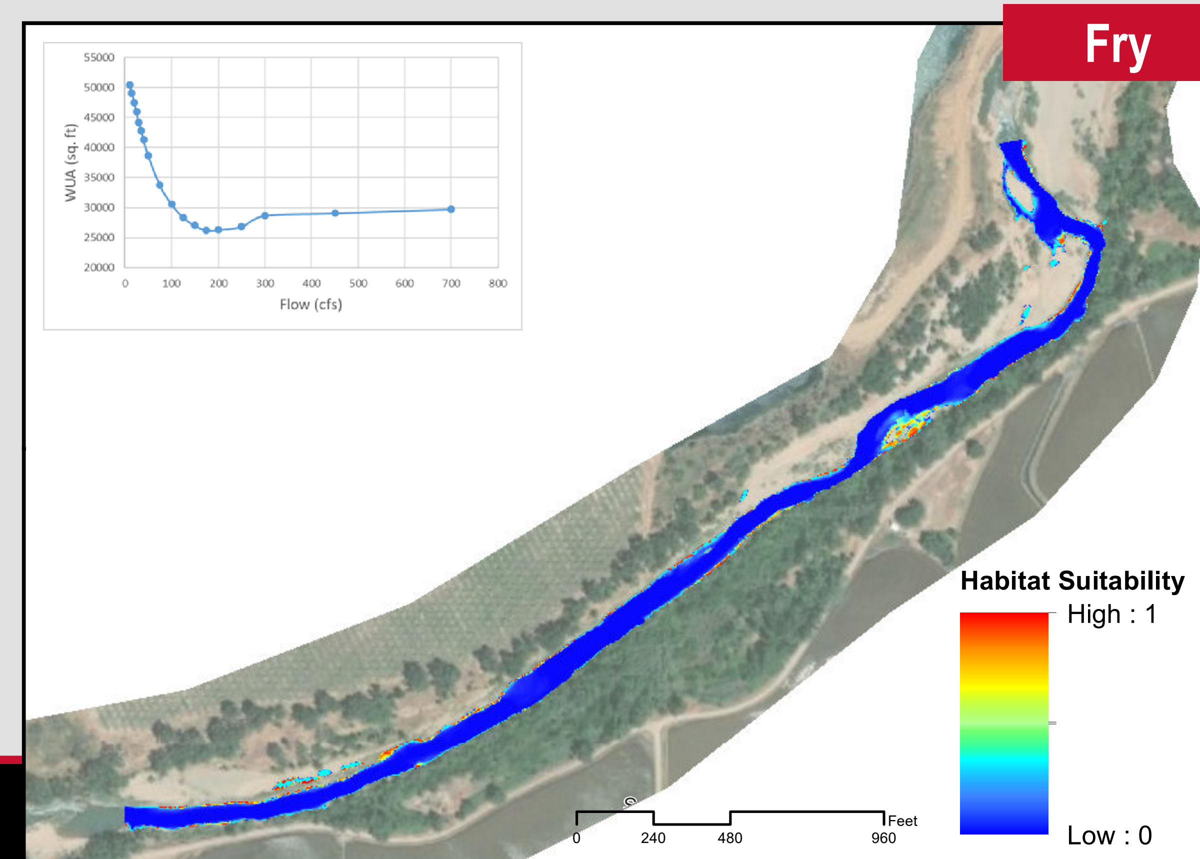
Spawning

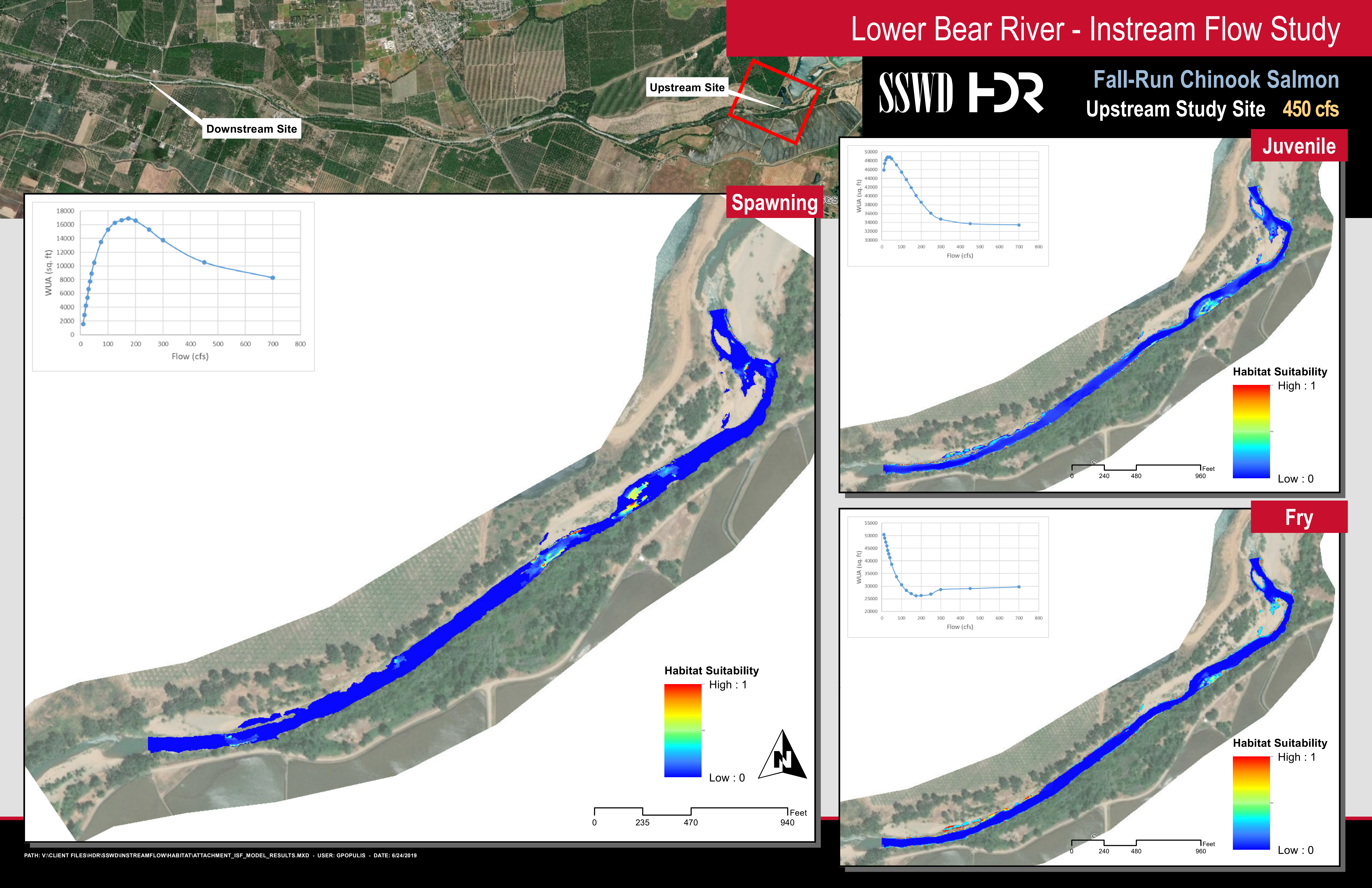


Juvenile



Fry



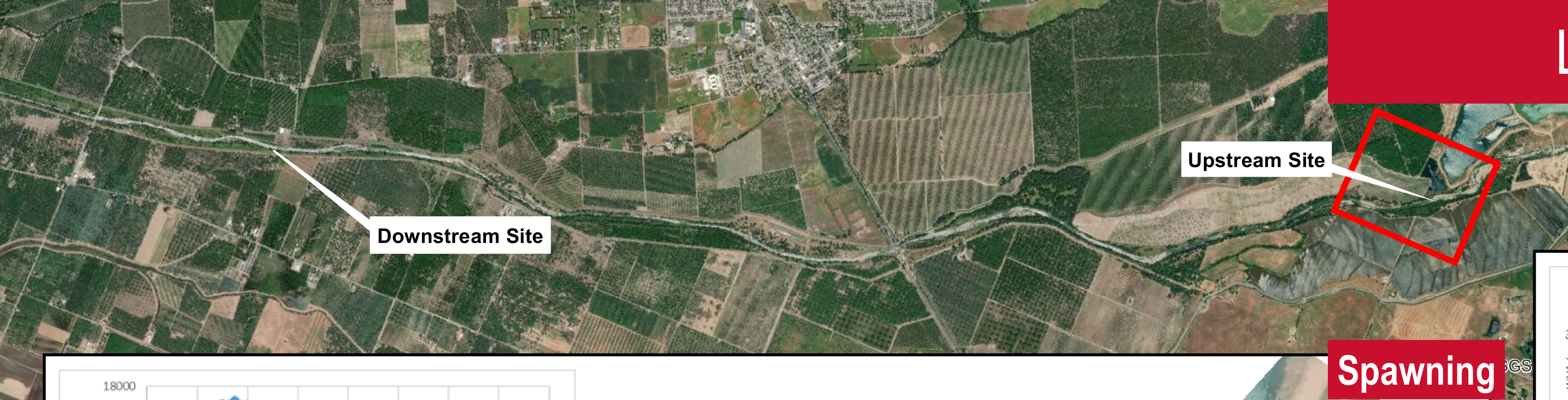


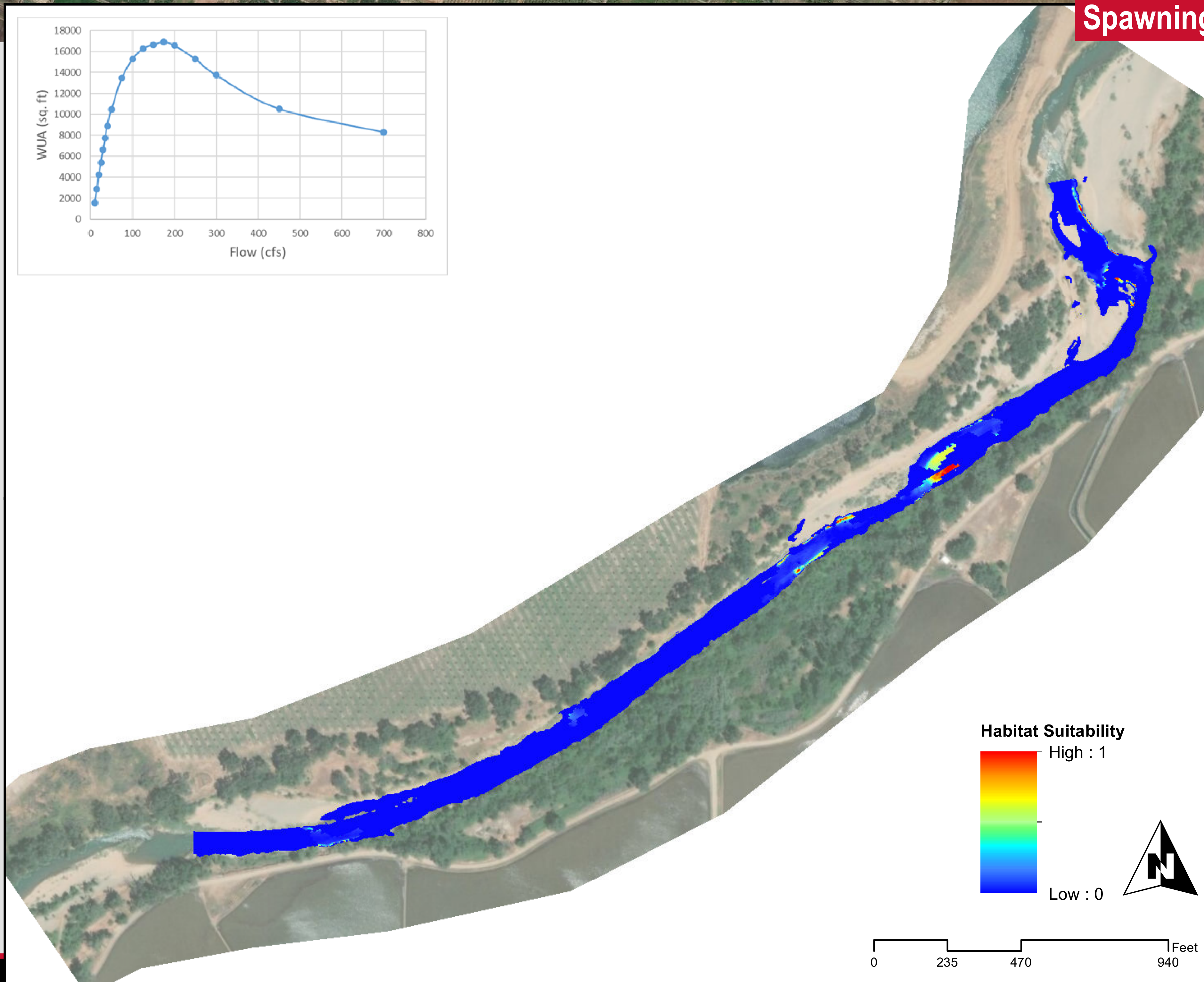
Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Upstream Study Site
450 cfs
Downstream Site
Upstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
235
470
940
N
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
240
480
960
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
240
480
960
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

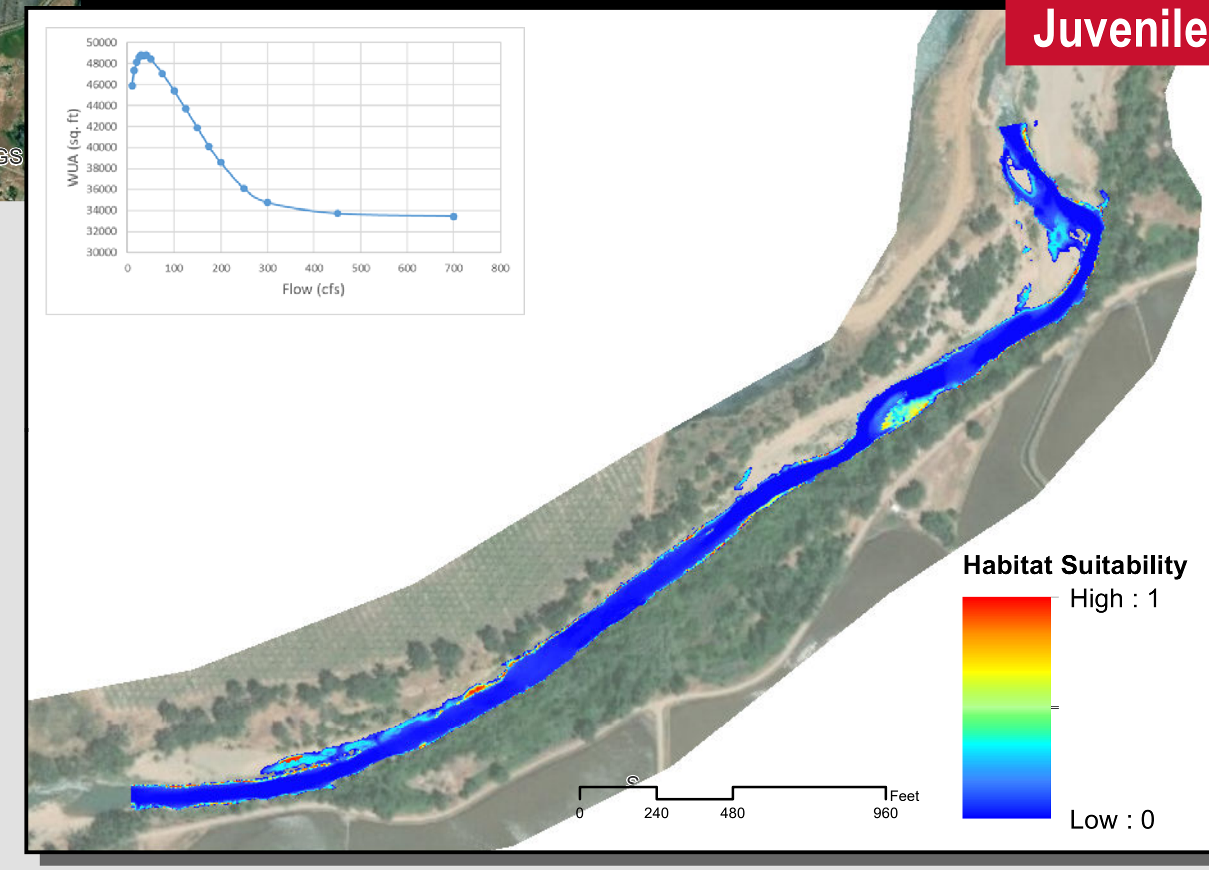
Lower Bear River - Instream Flow Study

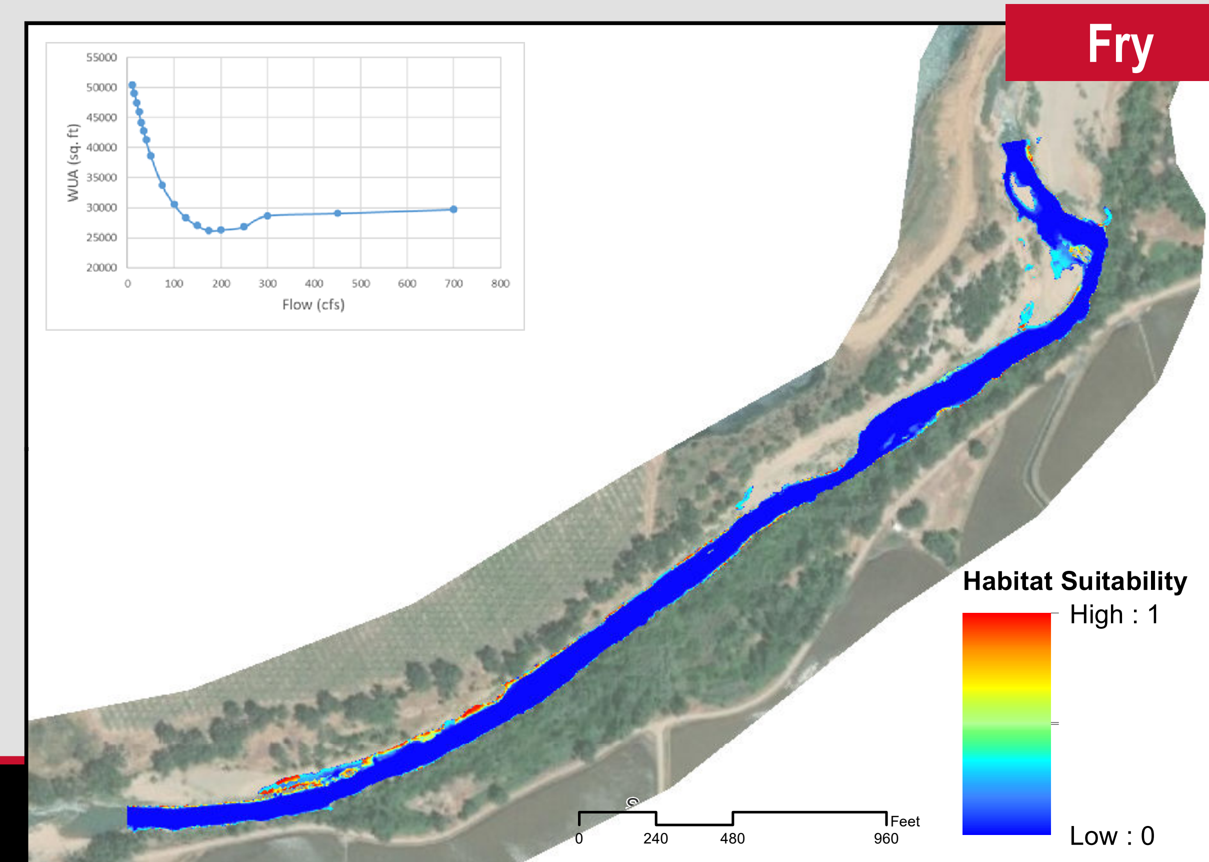
SSWD HDR

Fall-Run Chinook Salmon
Upstream Study Site 700 cfs









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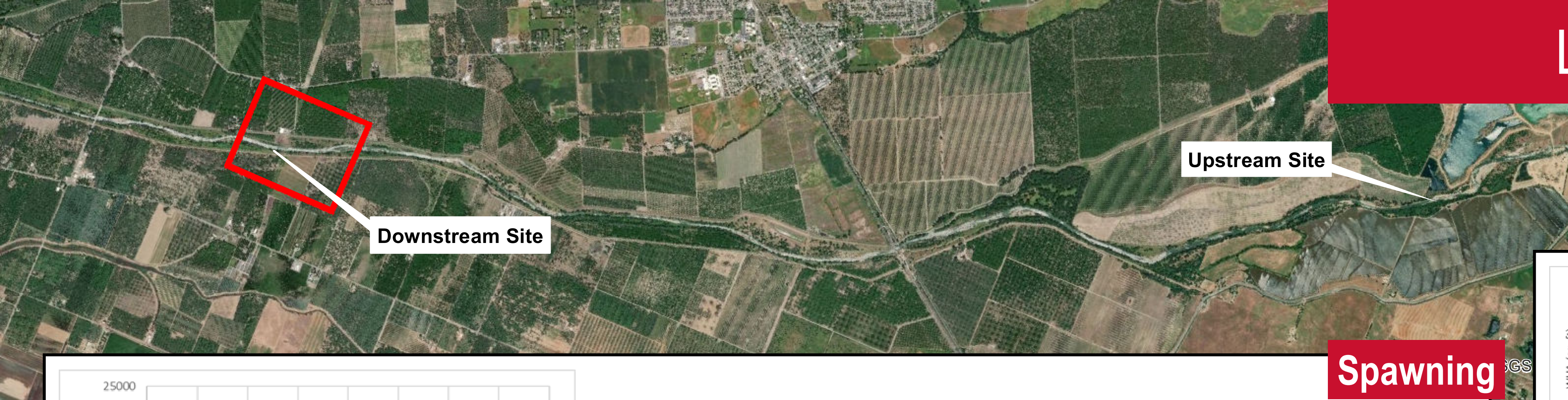
Lower Bear River - Instream Flow Study

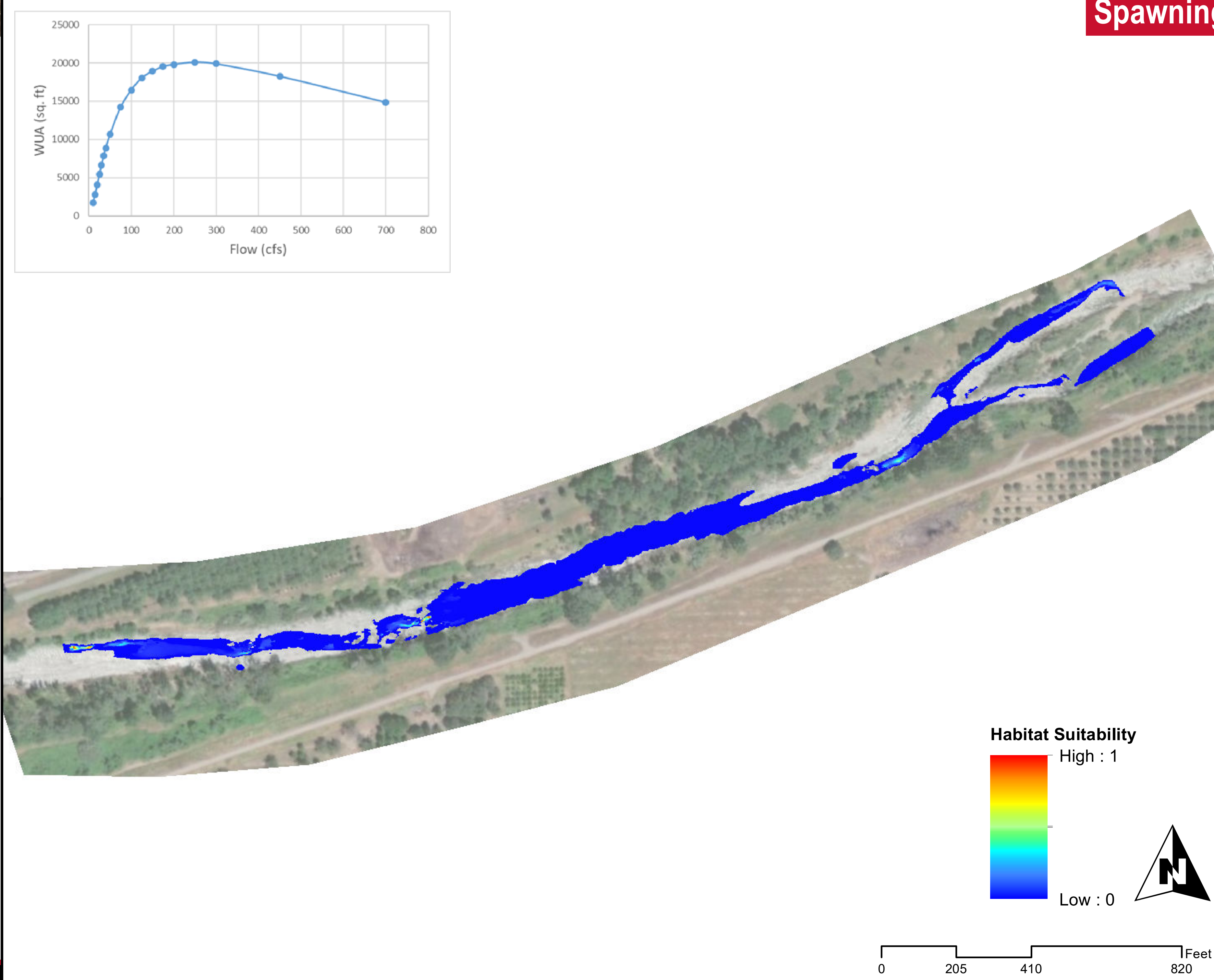
SSWD HDR

Fall-Run Chinook Salmon

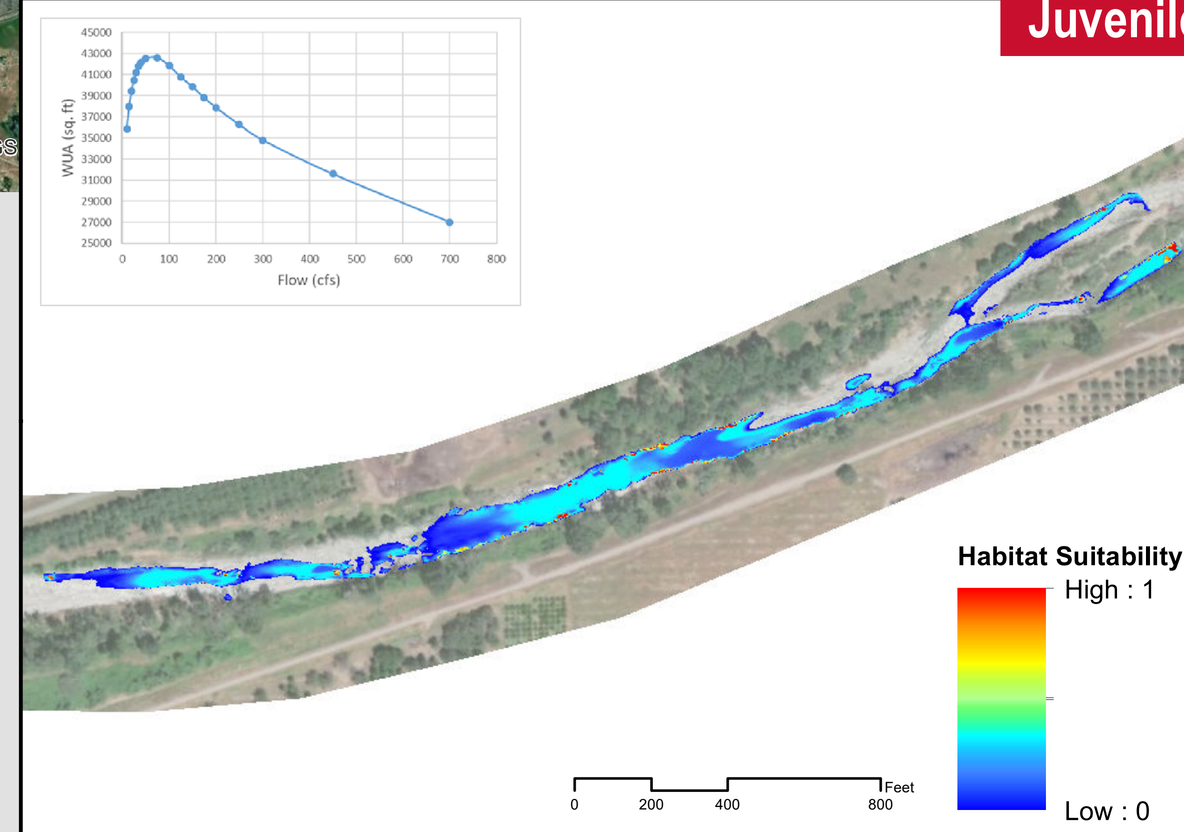
Downstream Study Site 10 cfs



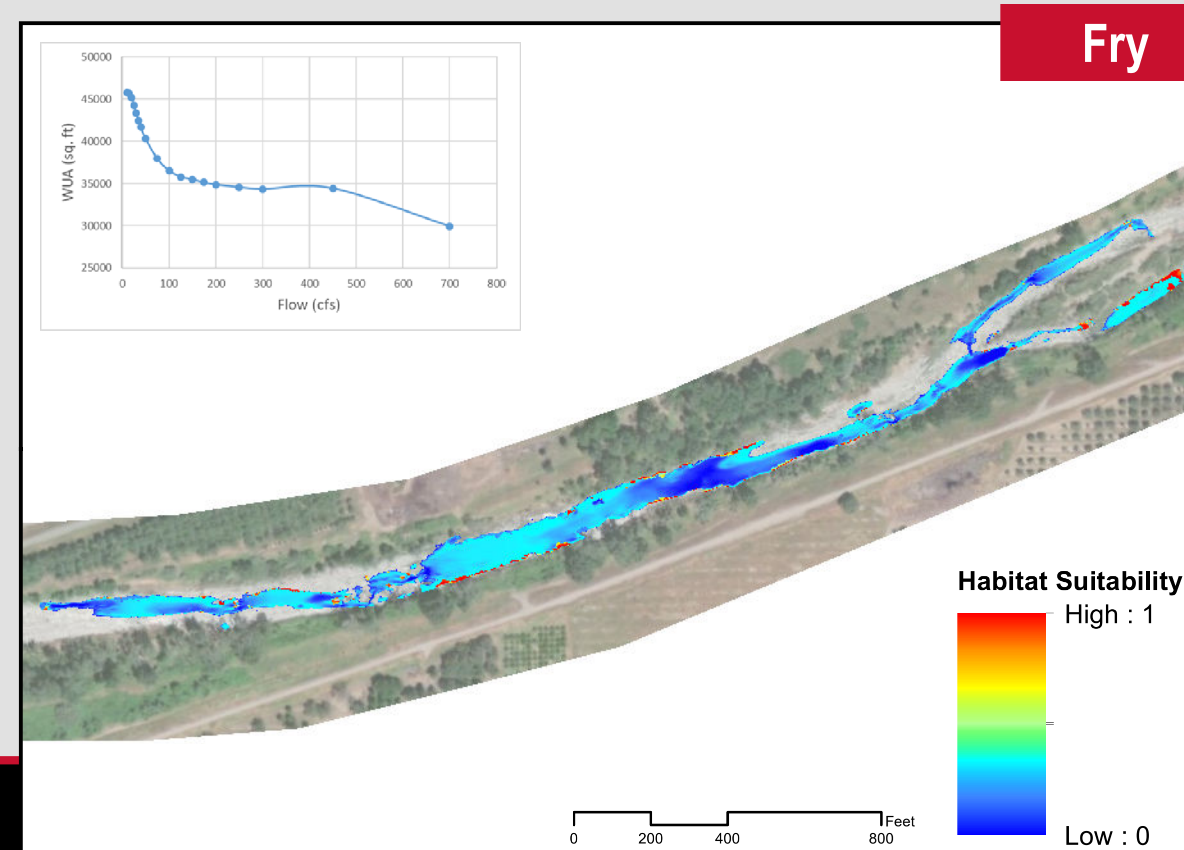
Spawning



Juvenile



Fry



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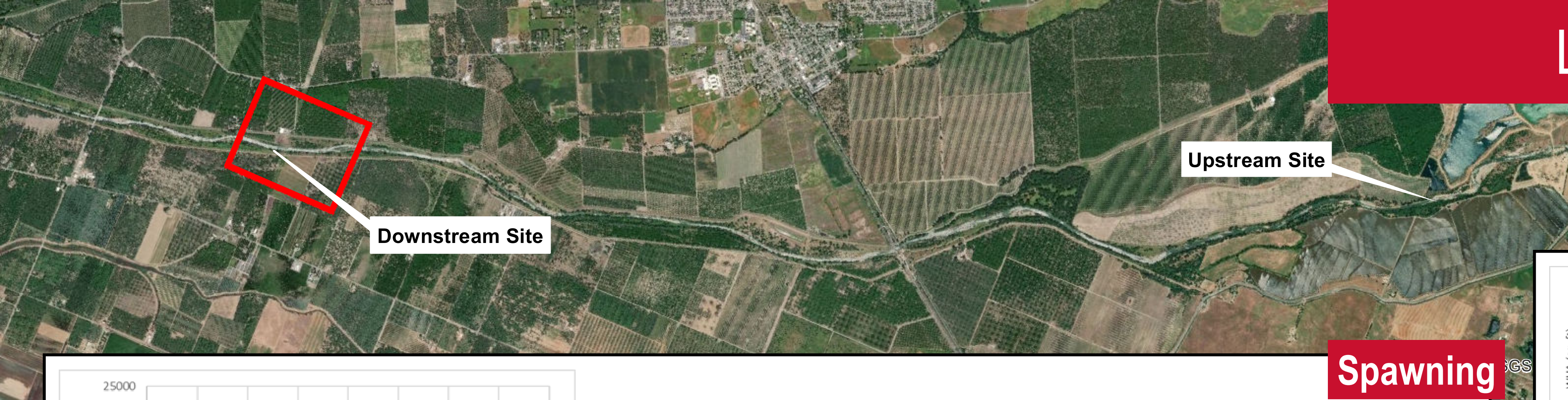
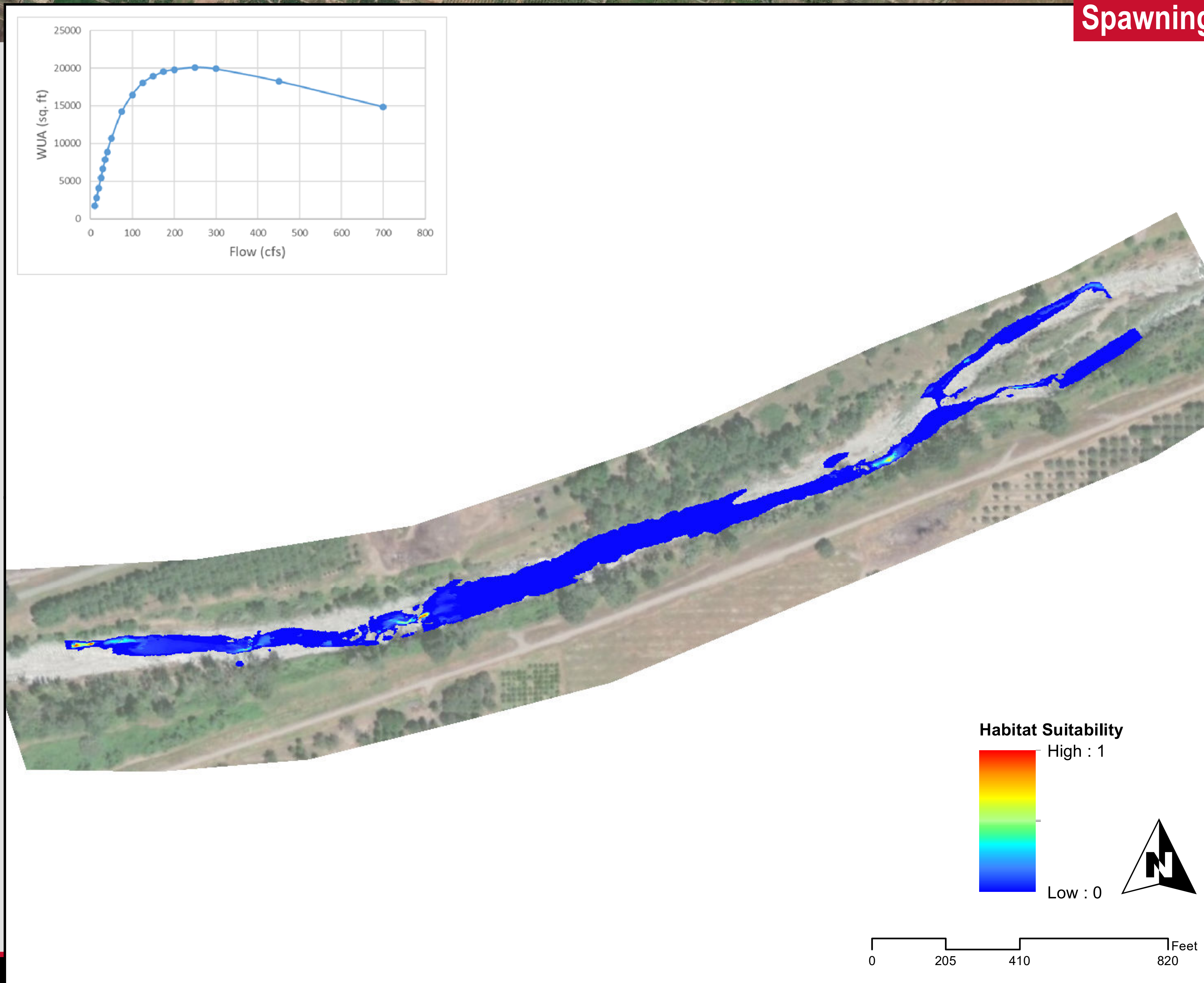
Lower Bear River - Instream Flow Study

SSWD HDR

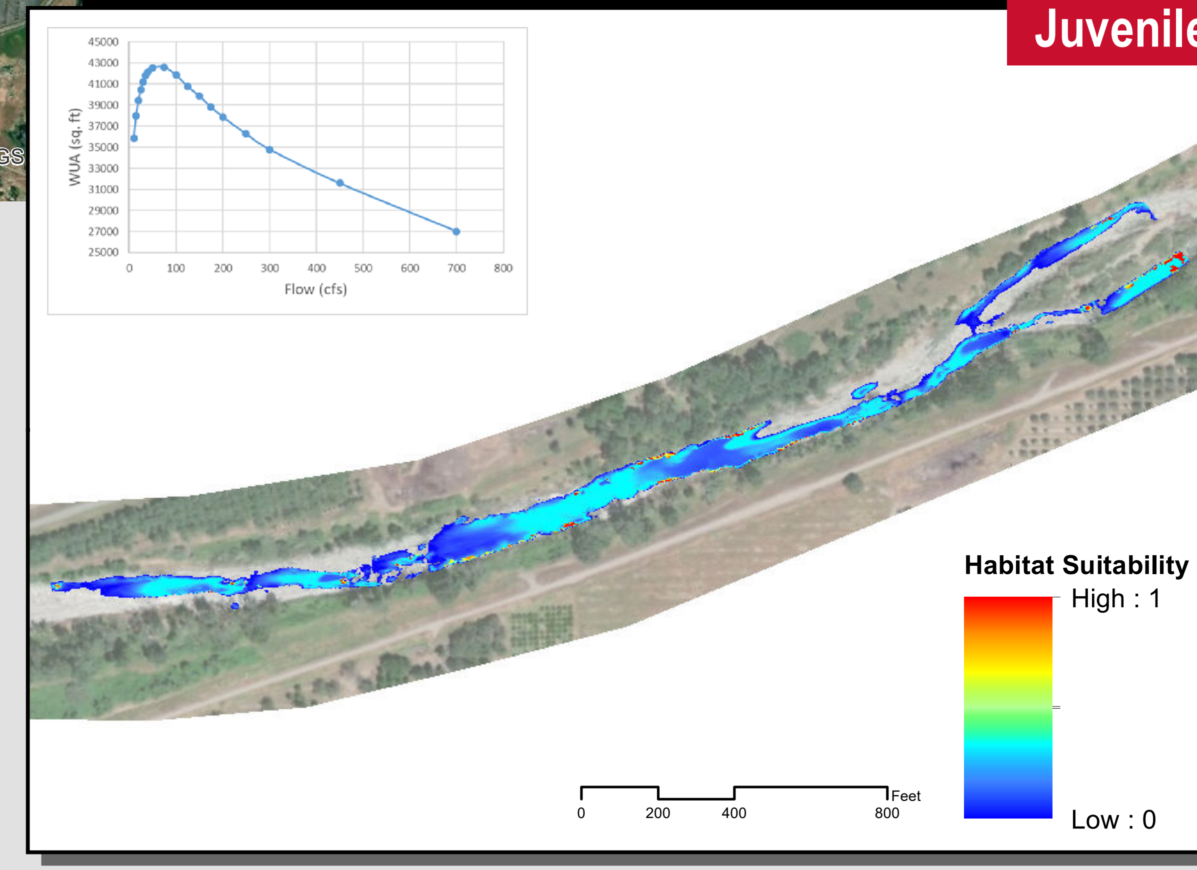
Fall-Run Chinook Salmon
Downstream Study Site 15 cfs



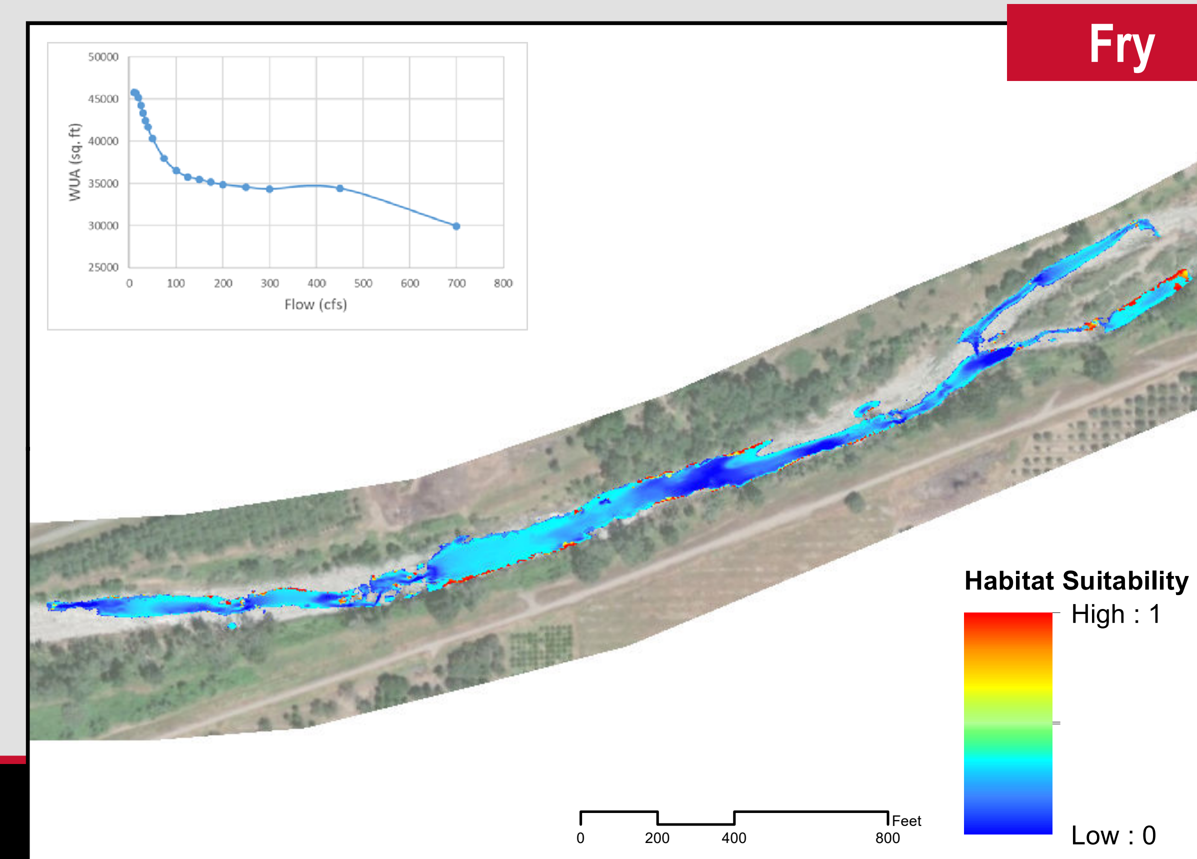
Spawning



Juvenile



Fry

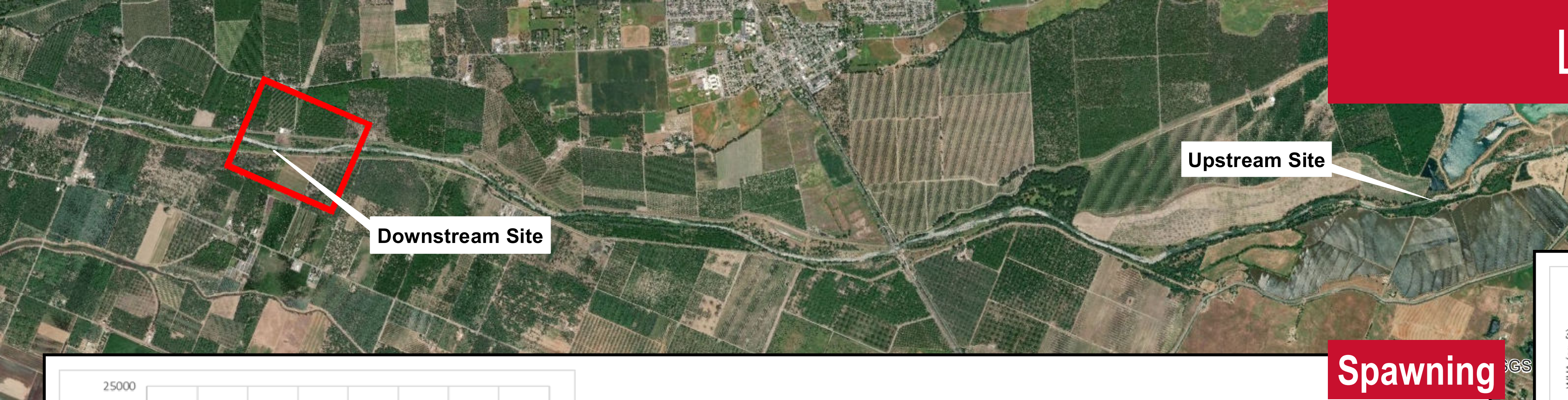


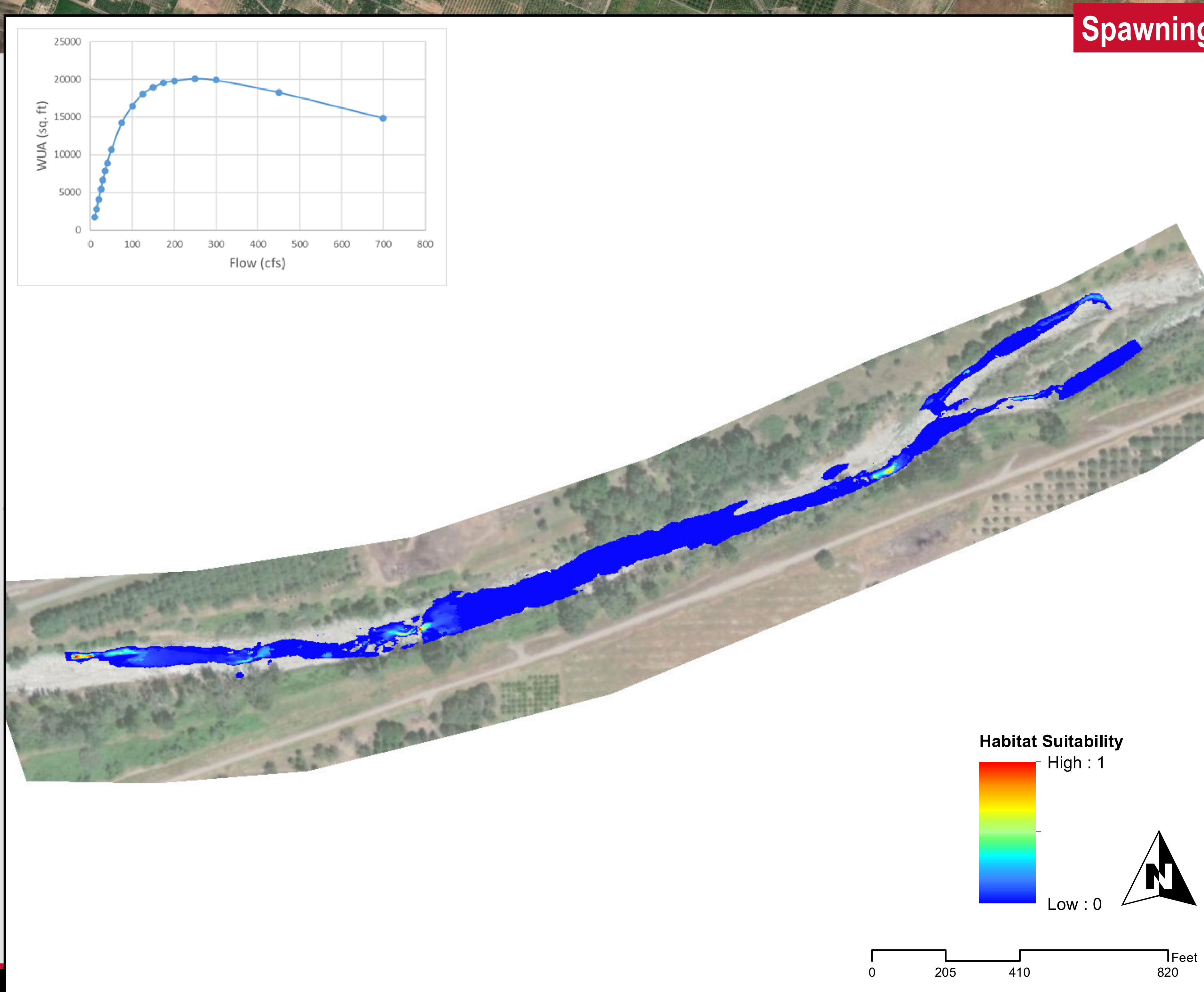
Lower Bear River - Instream Flow Study

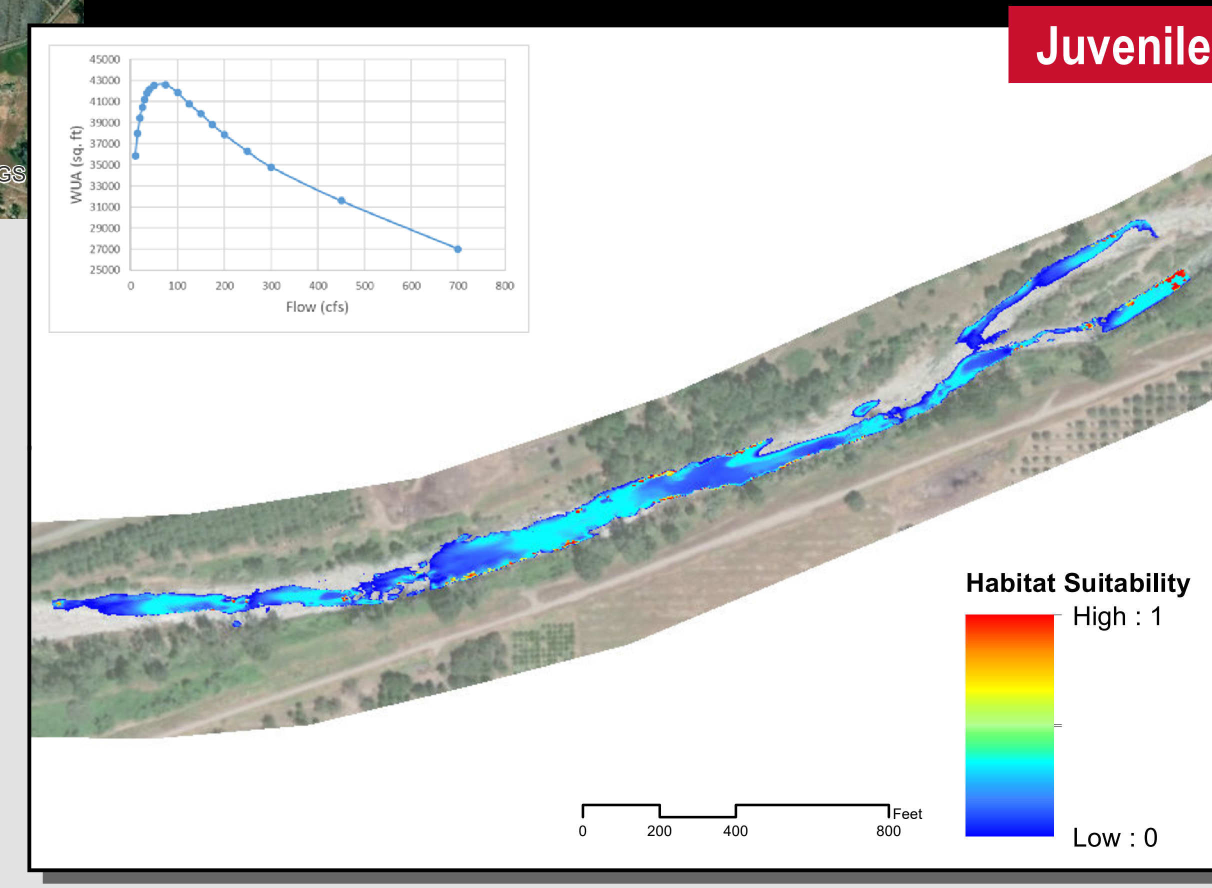
SSWD HDR

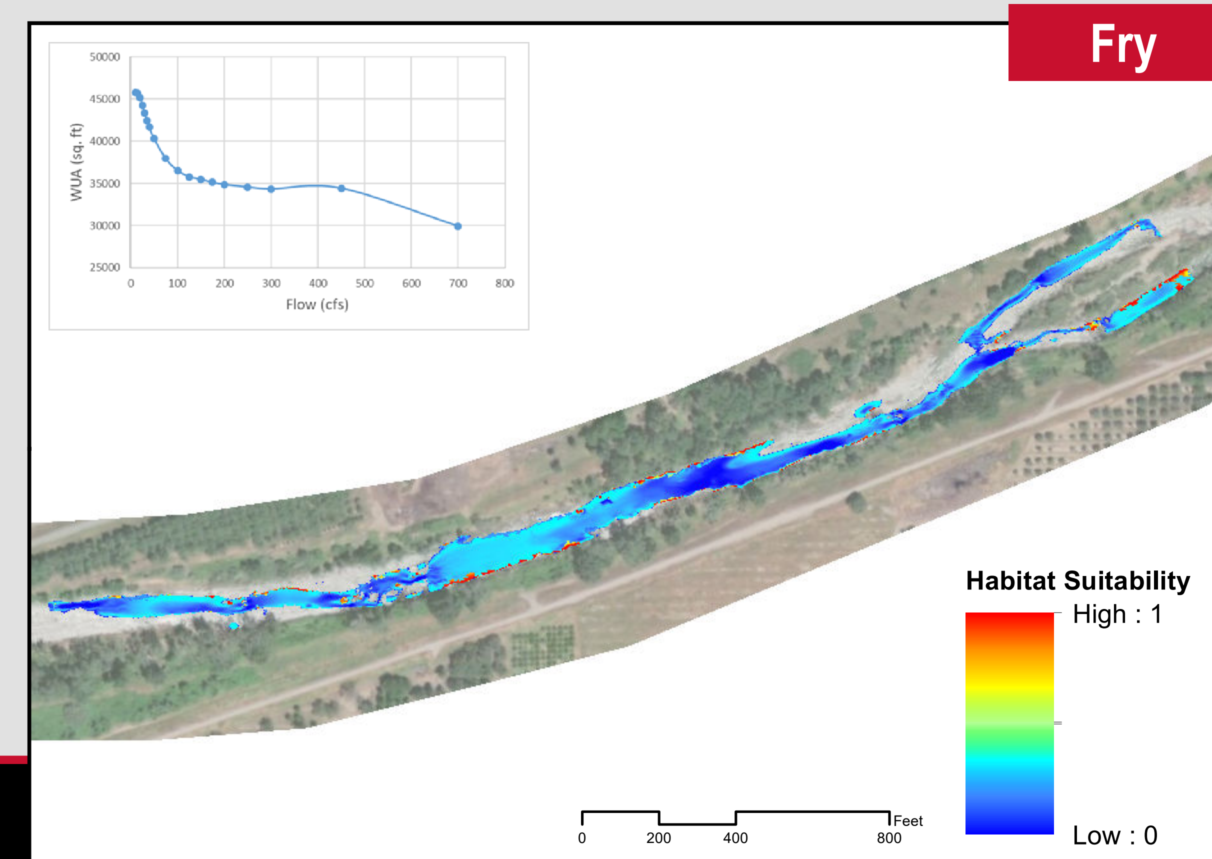
Fall-Run Chinook Salmon

Downstream Study Site 20 cfs









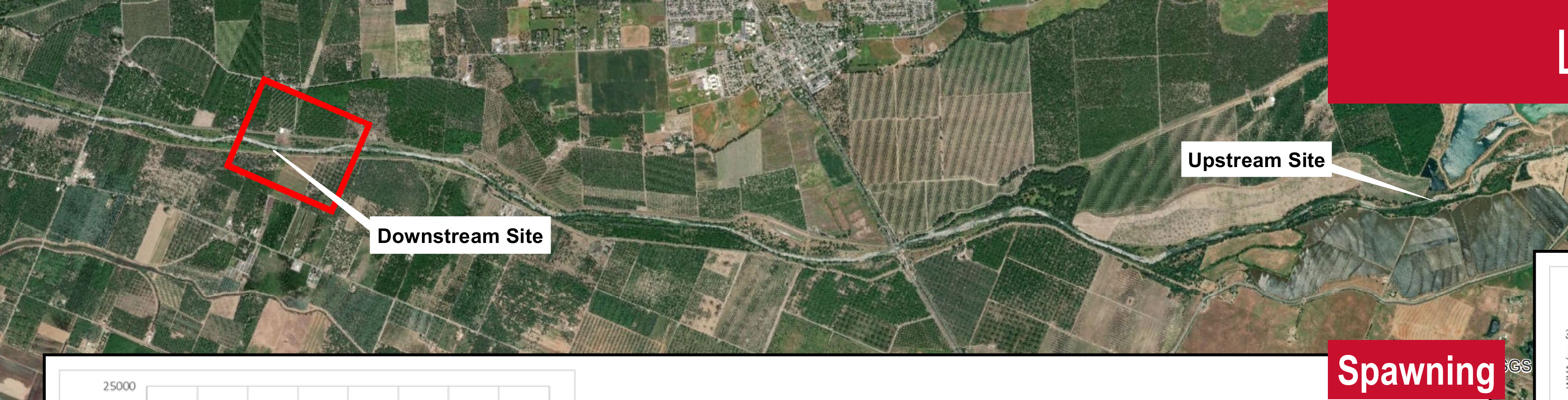
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

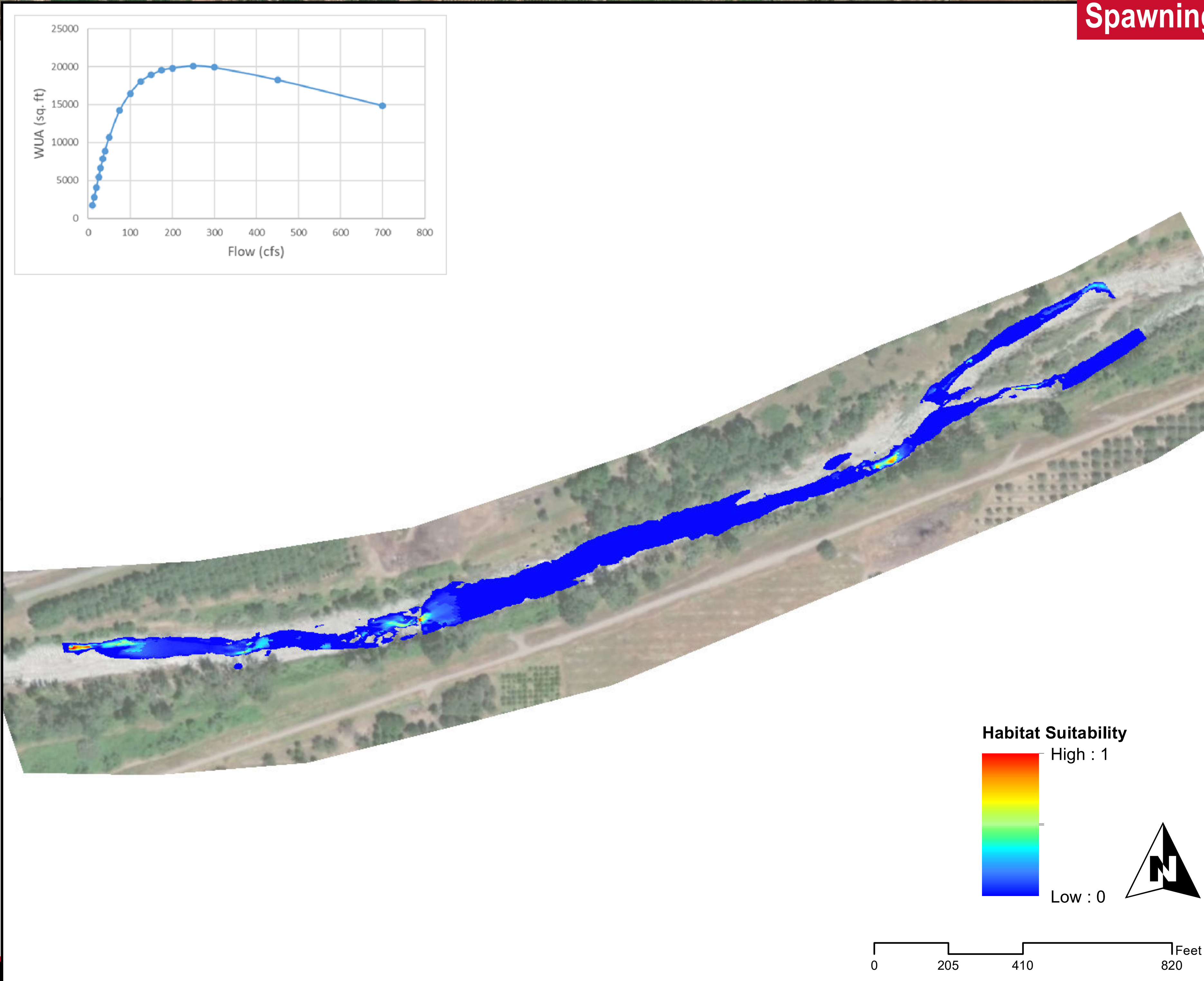
SSWD HDR

Fall-Run Chinook Salmon

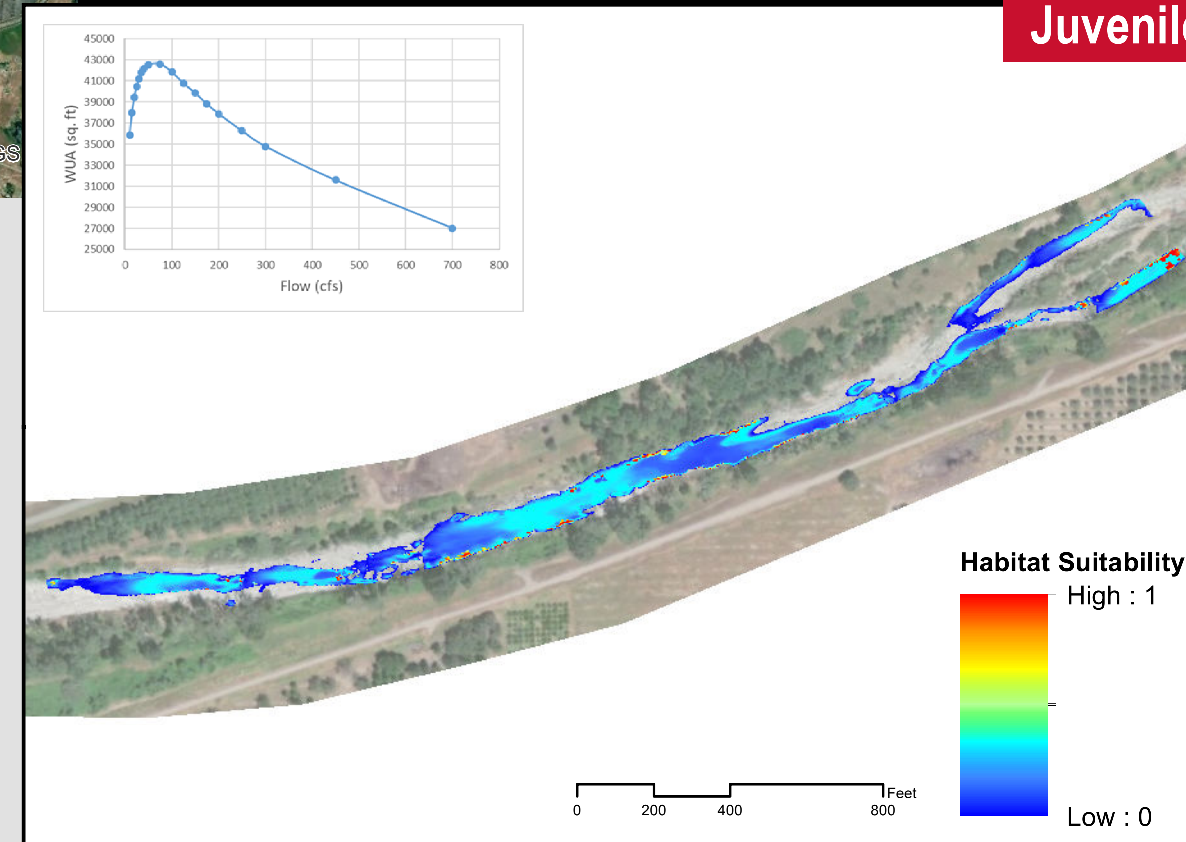
Downstream Study Site 25 cfs



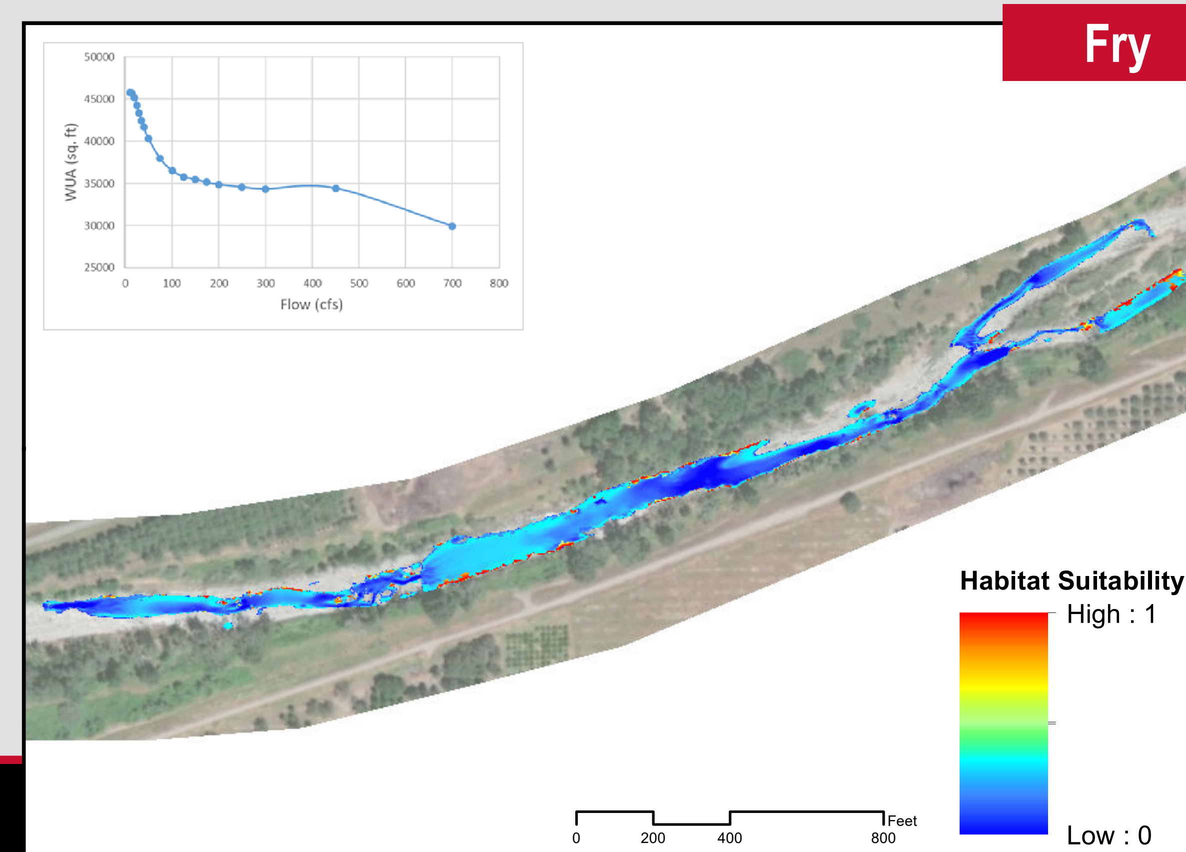
Spawning



Juvenile



Fry



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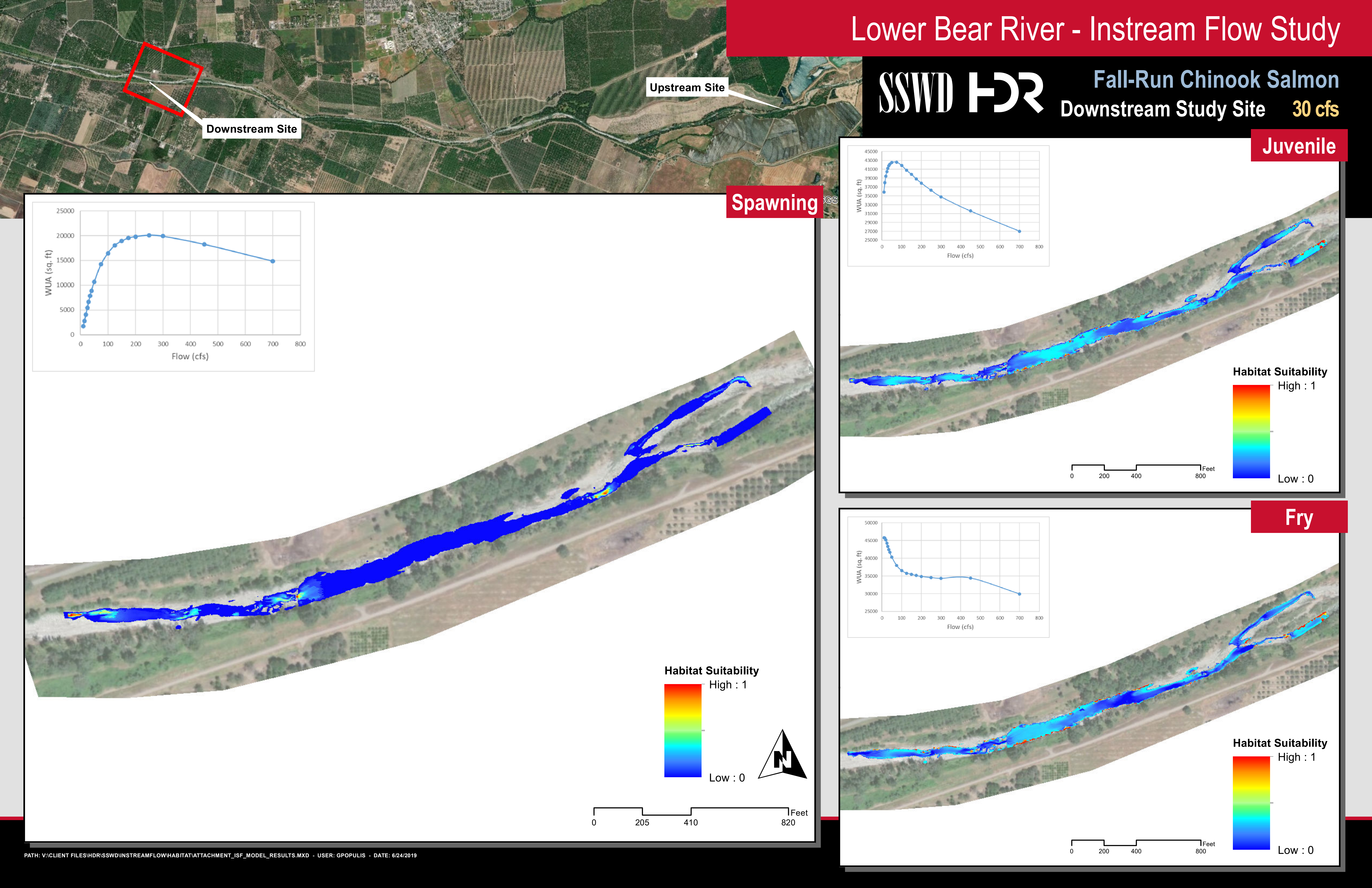
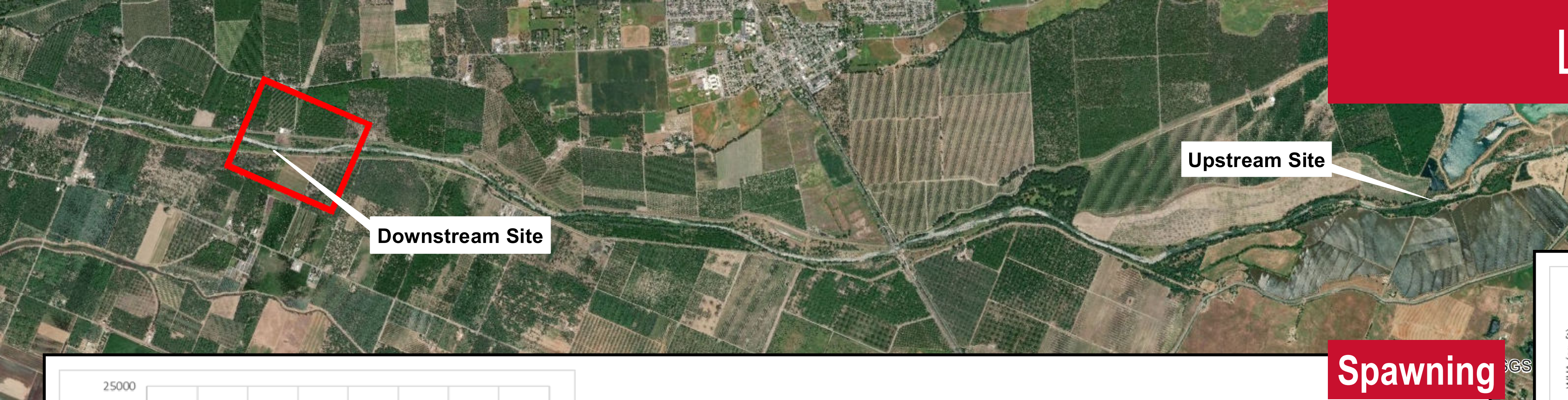

Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Downstream Study Site
30 cfs
Upstream Site
Downstream Site
Spawning
25000
20000
15000
10000
5000
0
WUA (sq. ft)
0 100 200 300 400 500 600 700 800
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 205 410 820
Feet
Juvenile
45000 43000 41000 39000 37000 35000 33000 31000 29000 27000 25000
WUA (sq. ft)
0 100 200 300 400 500 600 700 800
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 200 400 800
Feet
Fry
50000 45000 40000 35000 30000 25000
WUA (sq. ft)
0 100 200 300 400 500 600 700 800
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 200 400 800
Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

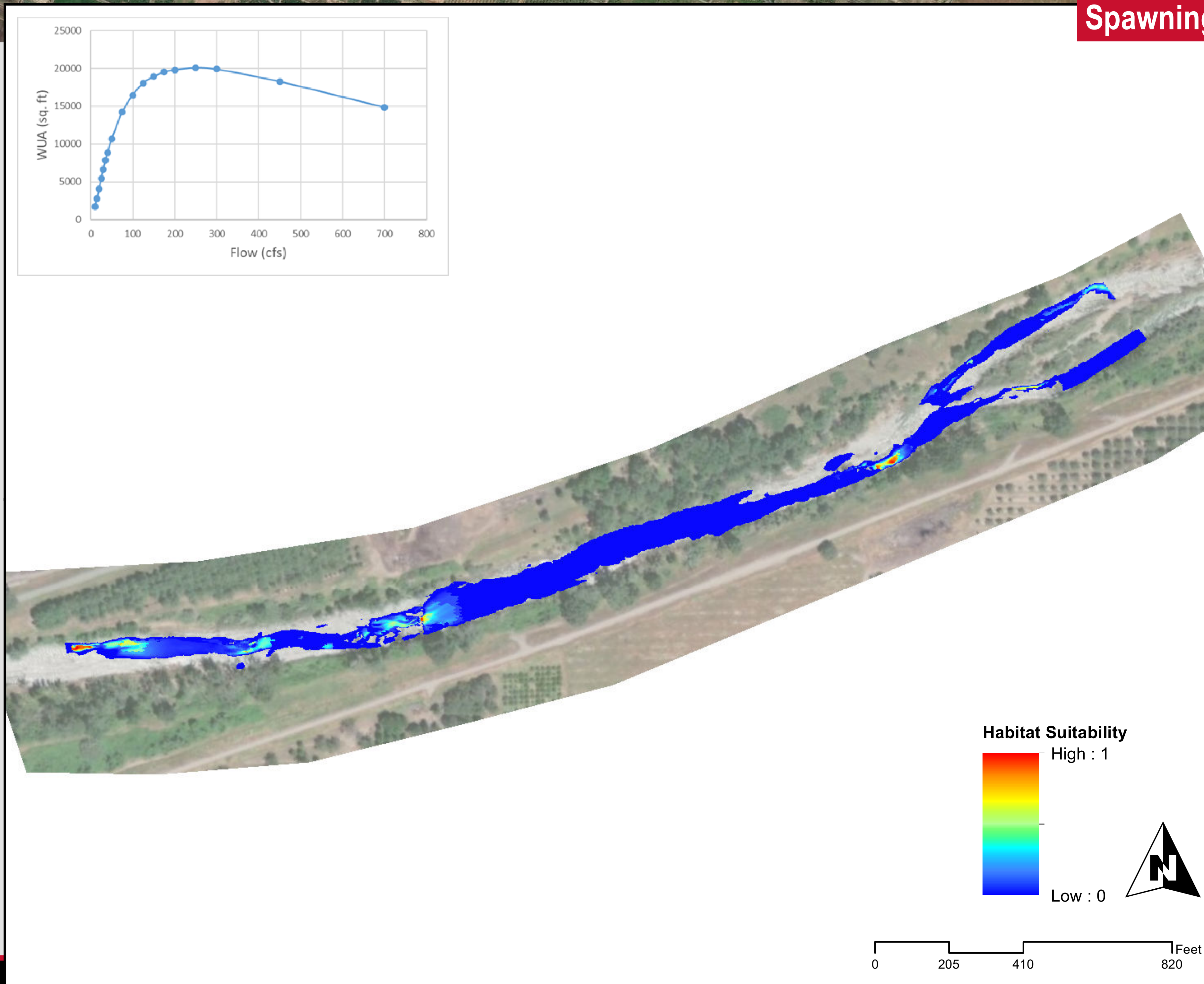
SSWD HDR

Fall-Run Chinook Salmon

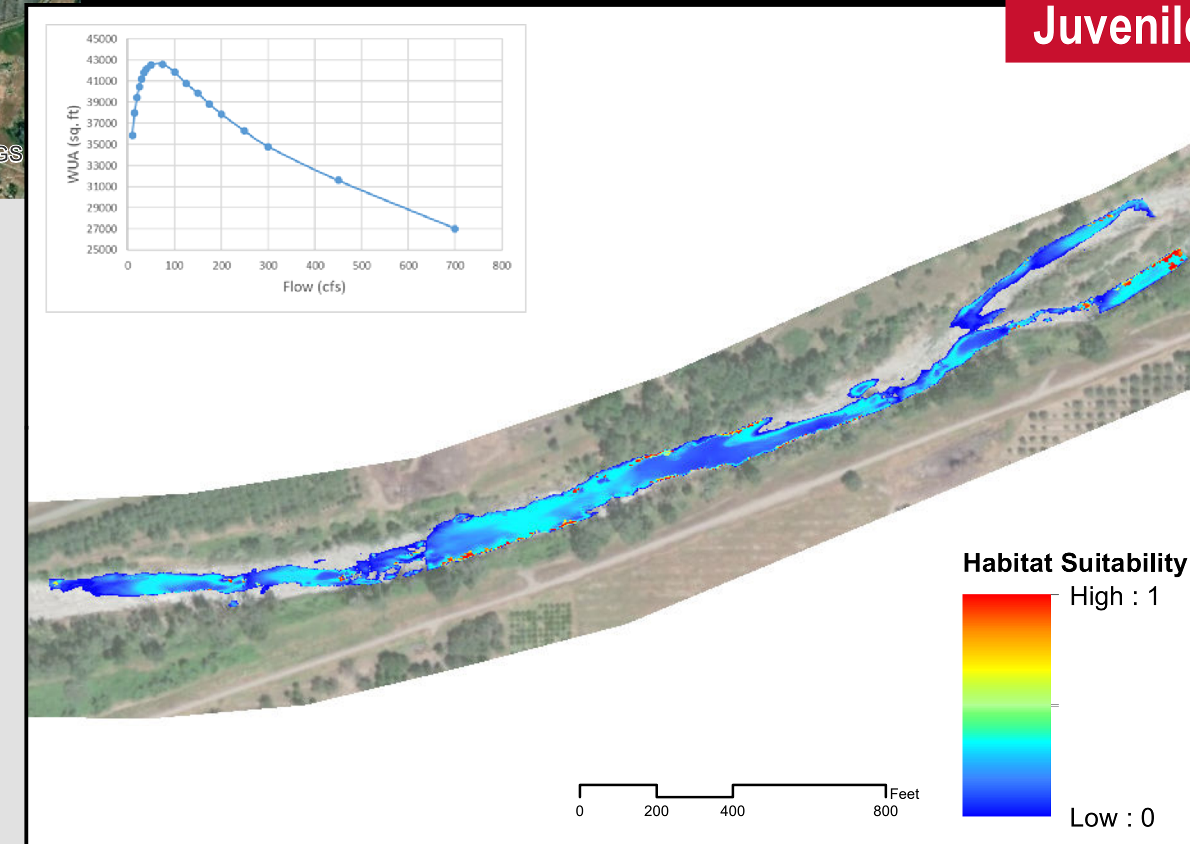
Downstream Study Site **35 cfs**



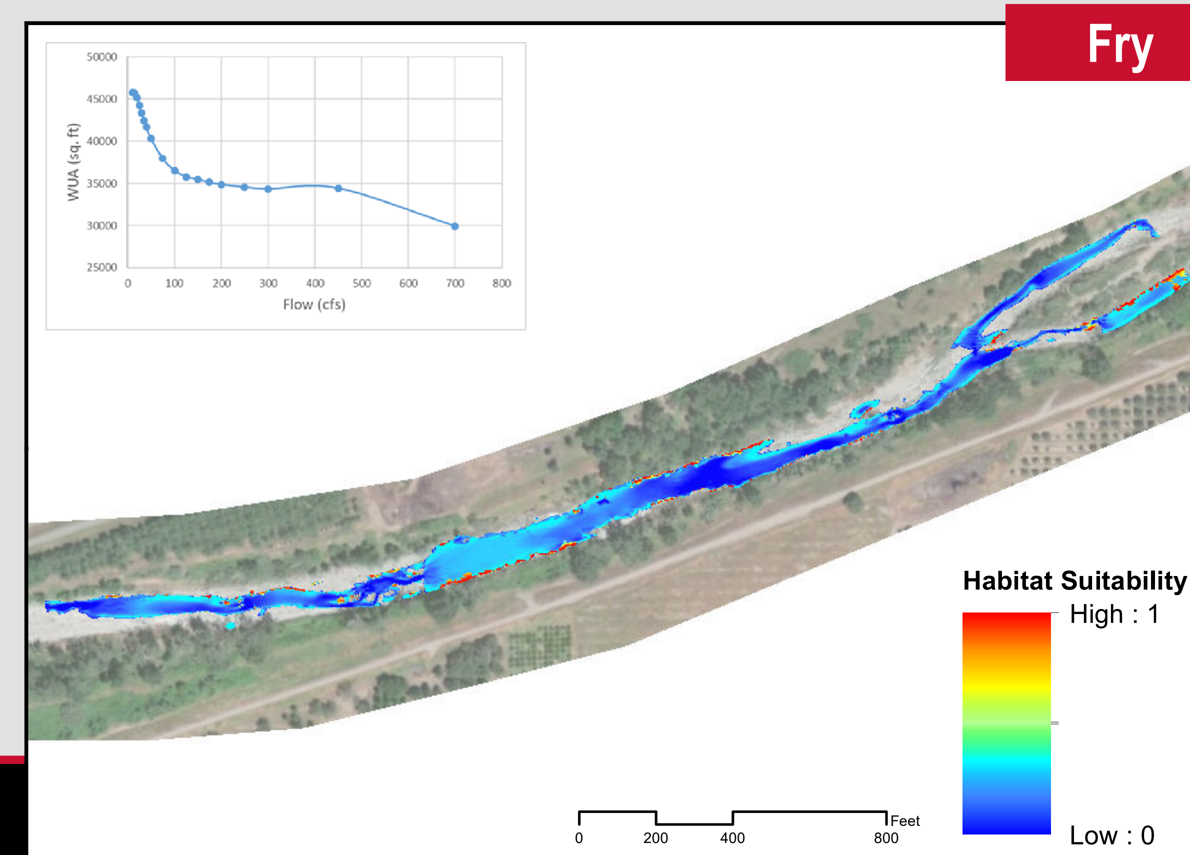
Spawning



Juvenile



Fry



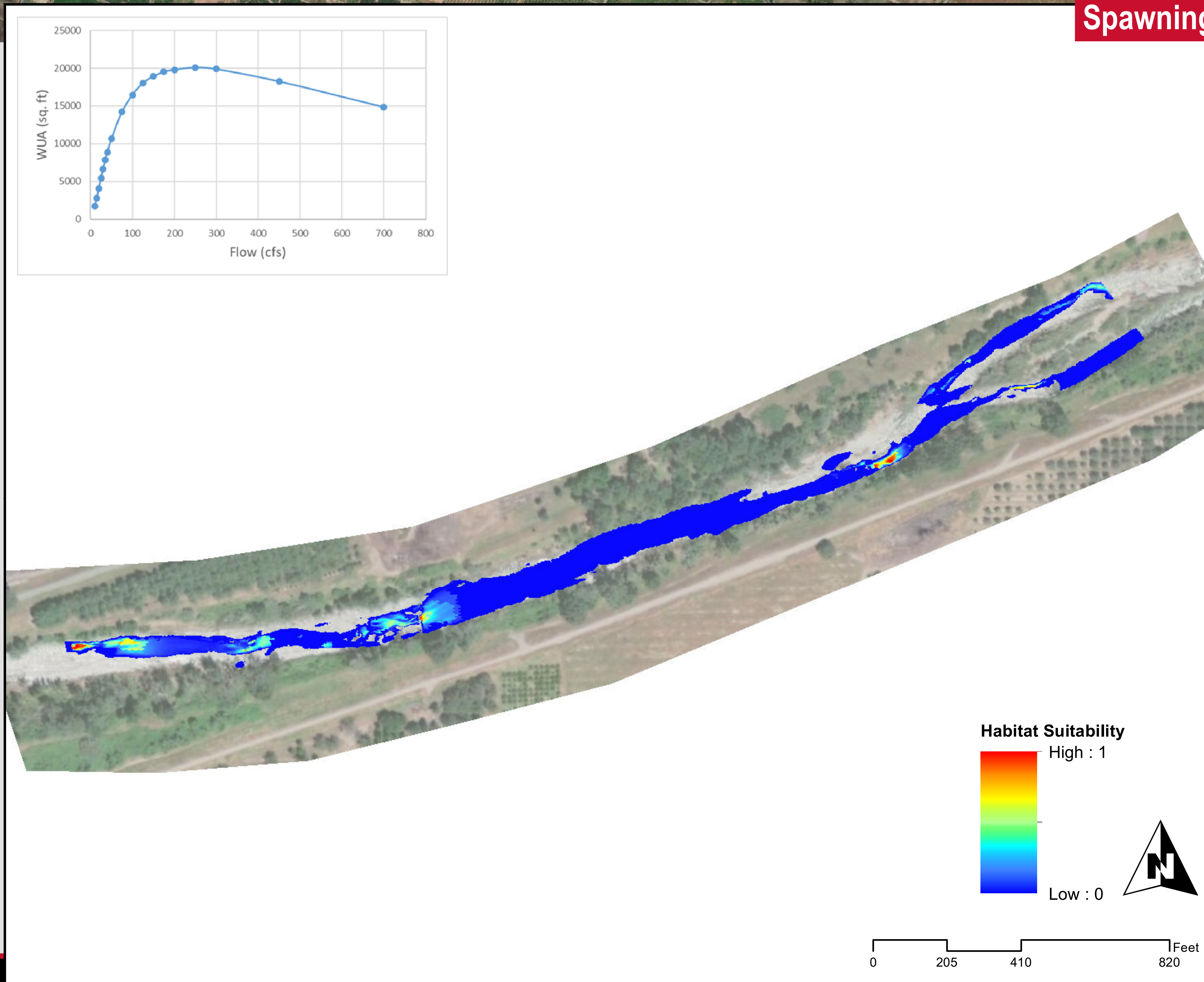
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

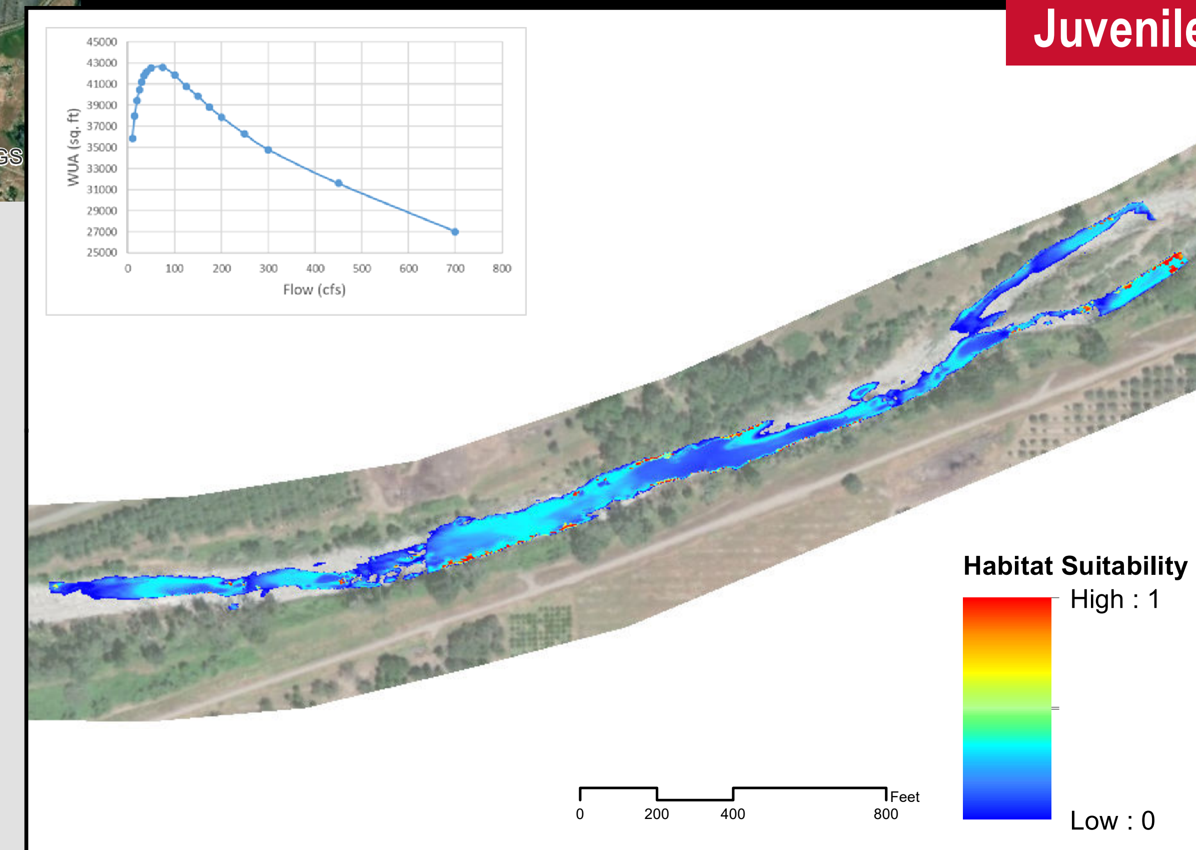
Lower Bear River - Instream Flow Study

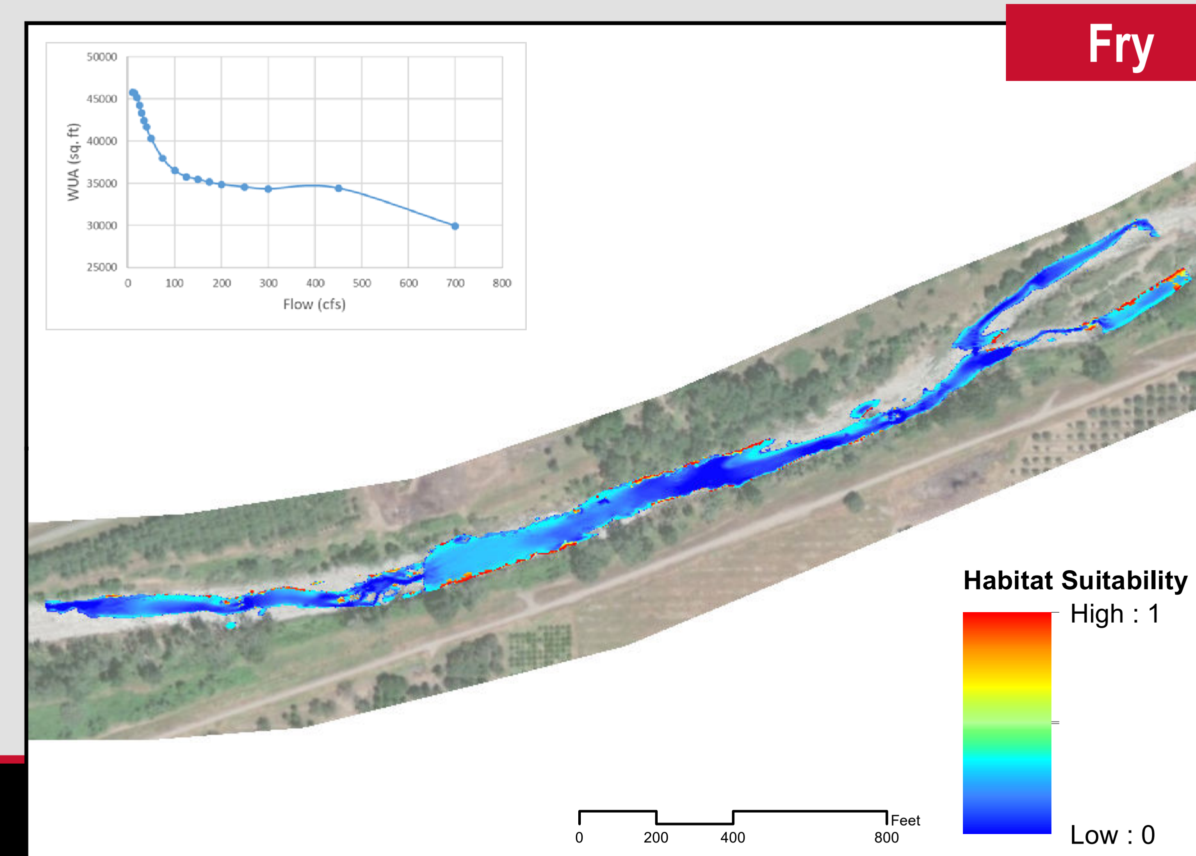
SSWD HDR

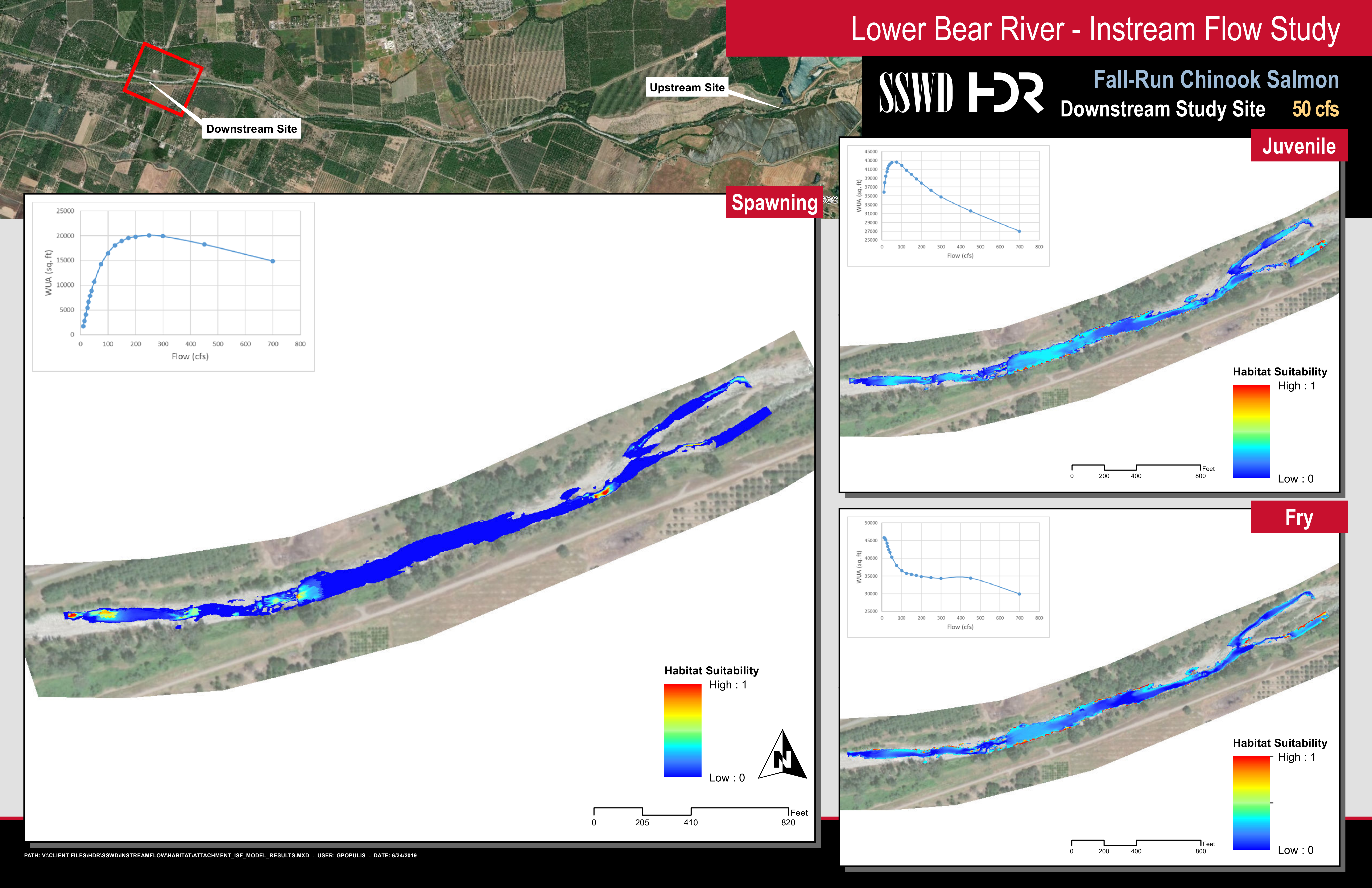
Fall-Run Chinook Salmon

Downstream Study Site 40 cfs



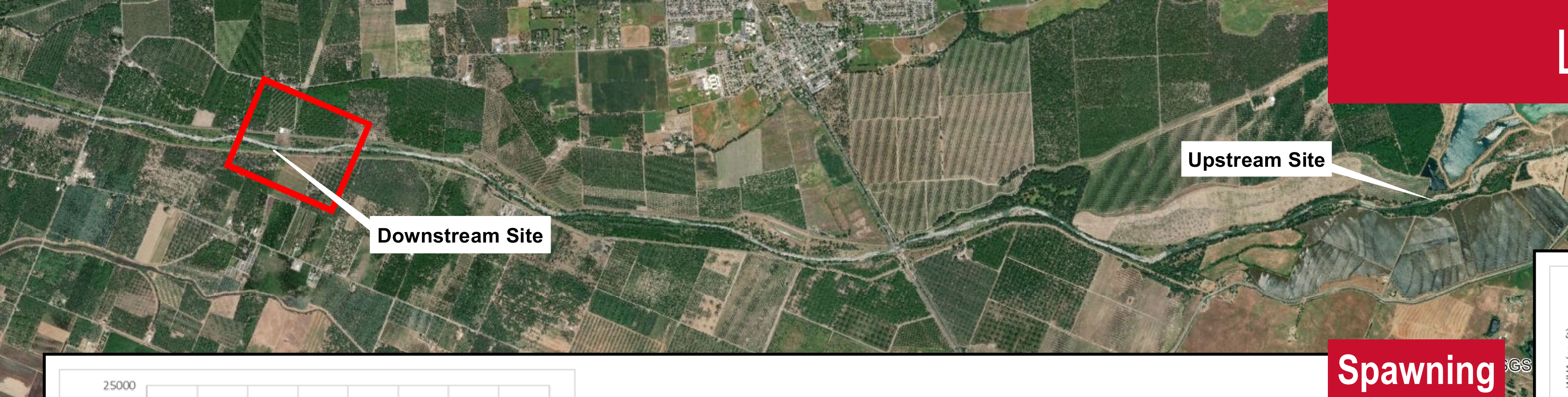






Lower Bear River - Instream Flow Study
Fall-Run Chinook Salmon
Downstream Study Site
50 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
205
410
820
Feet
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
200
400
800
Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
200
400
800
Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

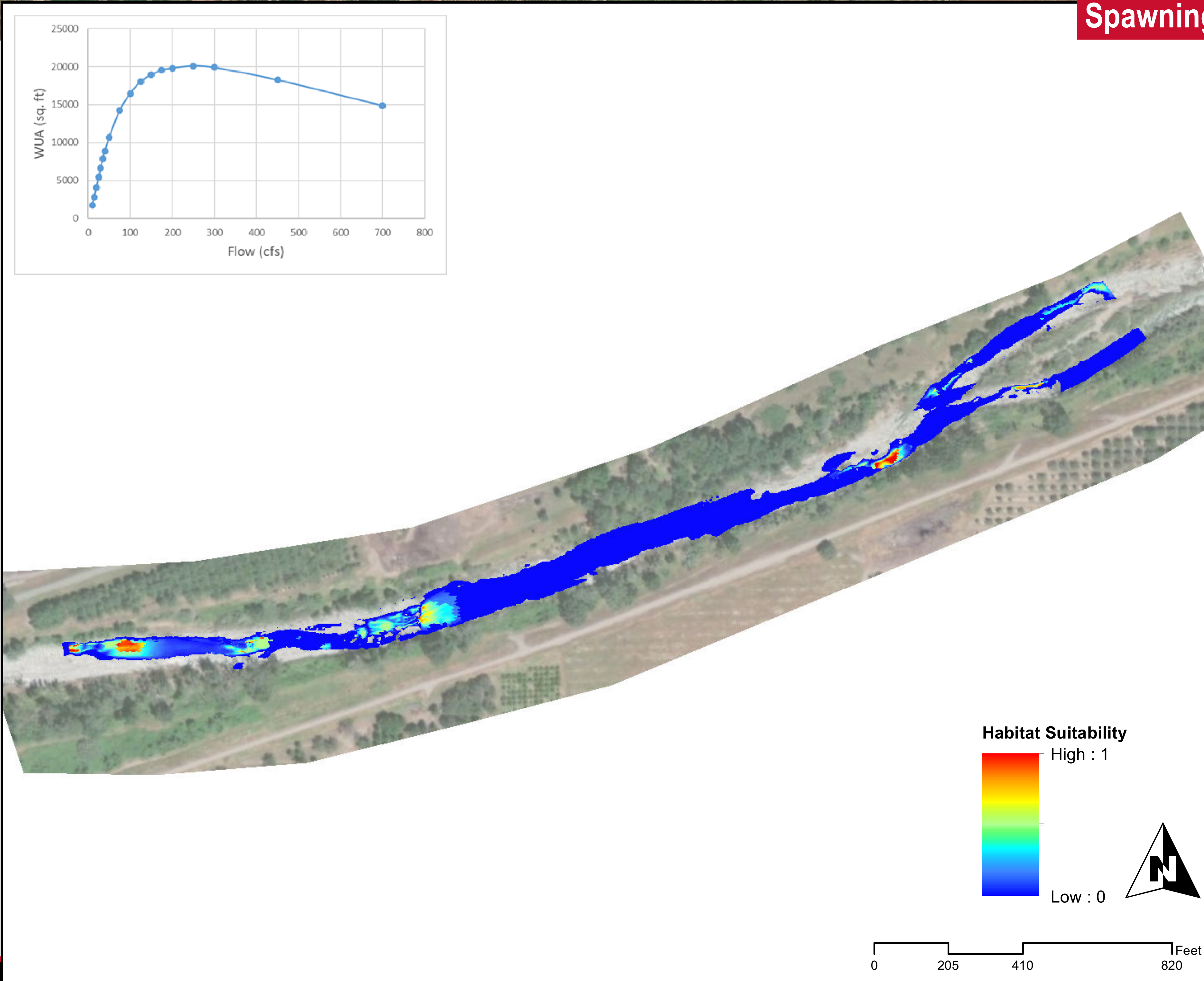


SSWD HDR

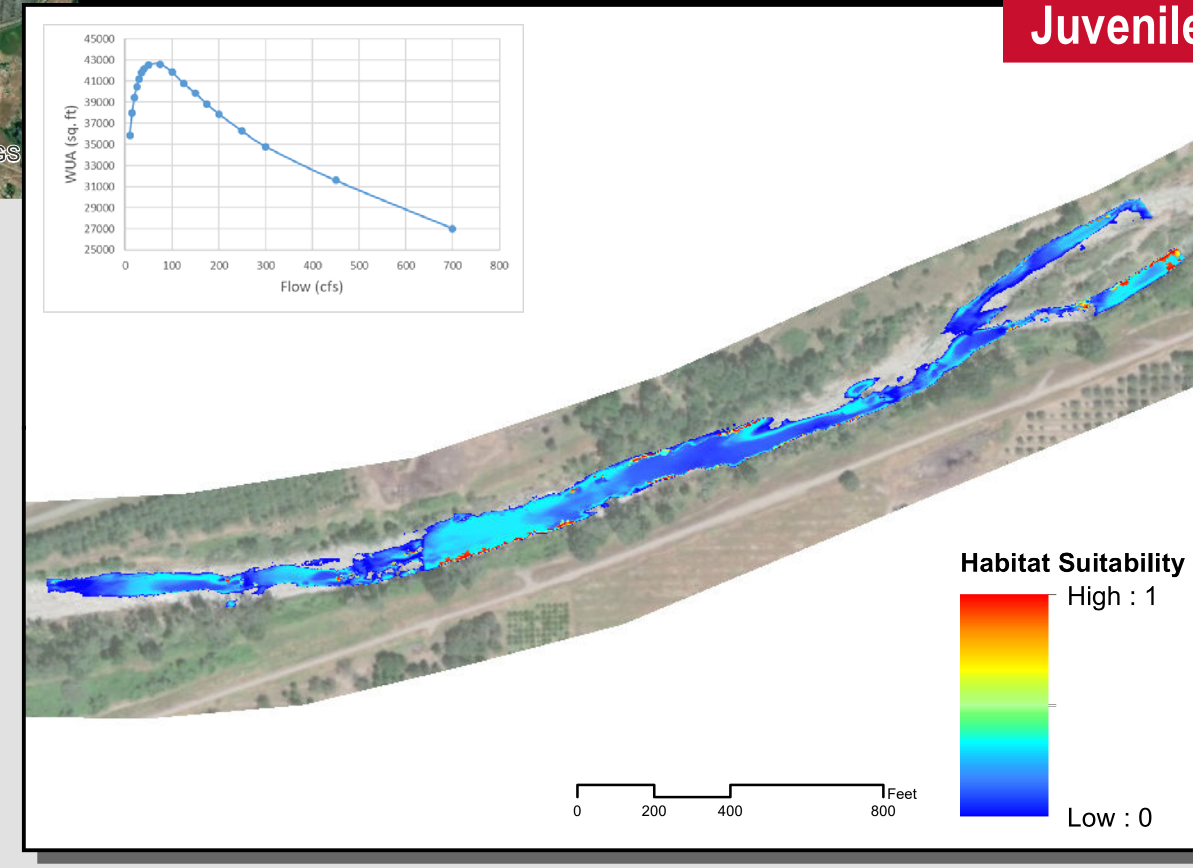
Fall-Run Chinook Salmon

Downstream Study Site 75 cfs

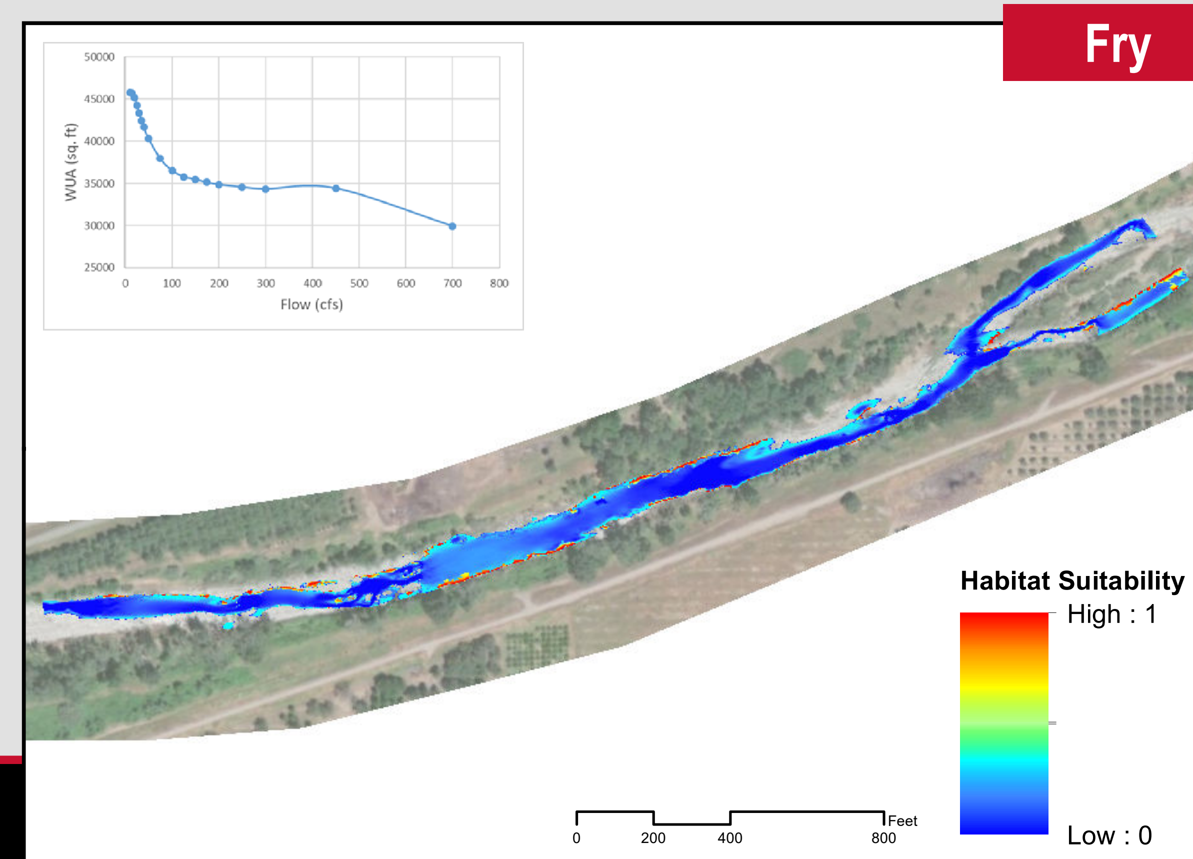
Spawning



Juvenile



Fry

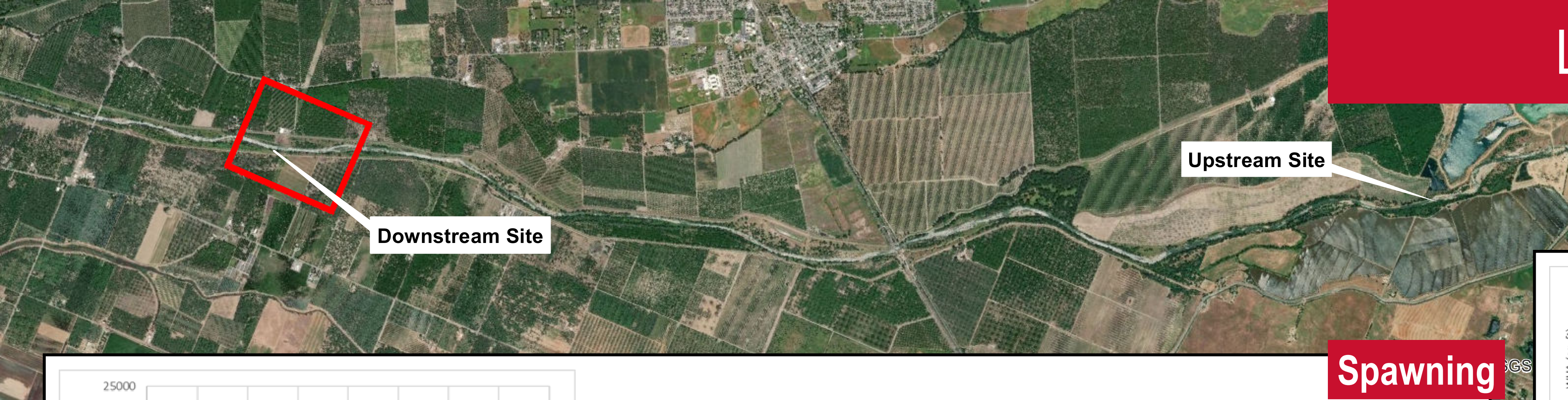


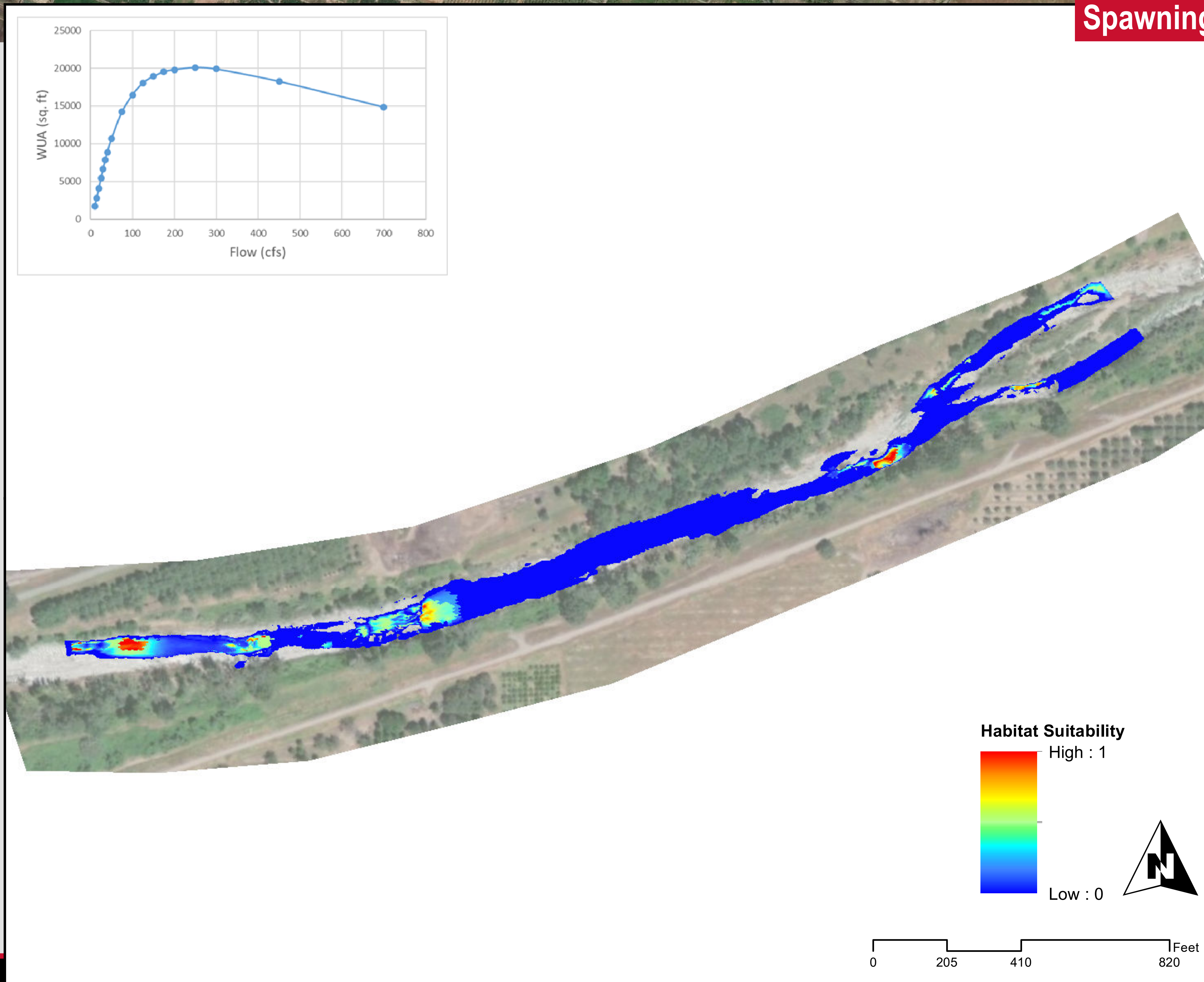
Lower Bear River - Instream Flow Study

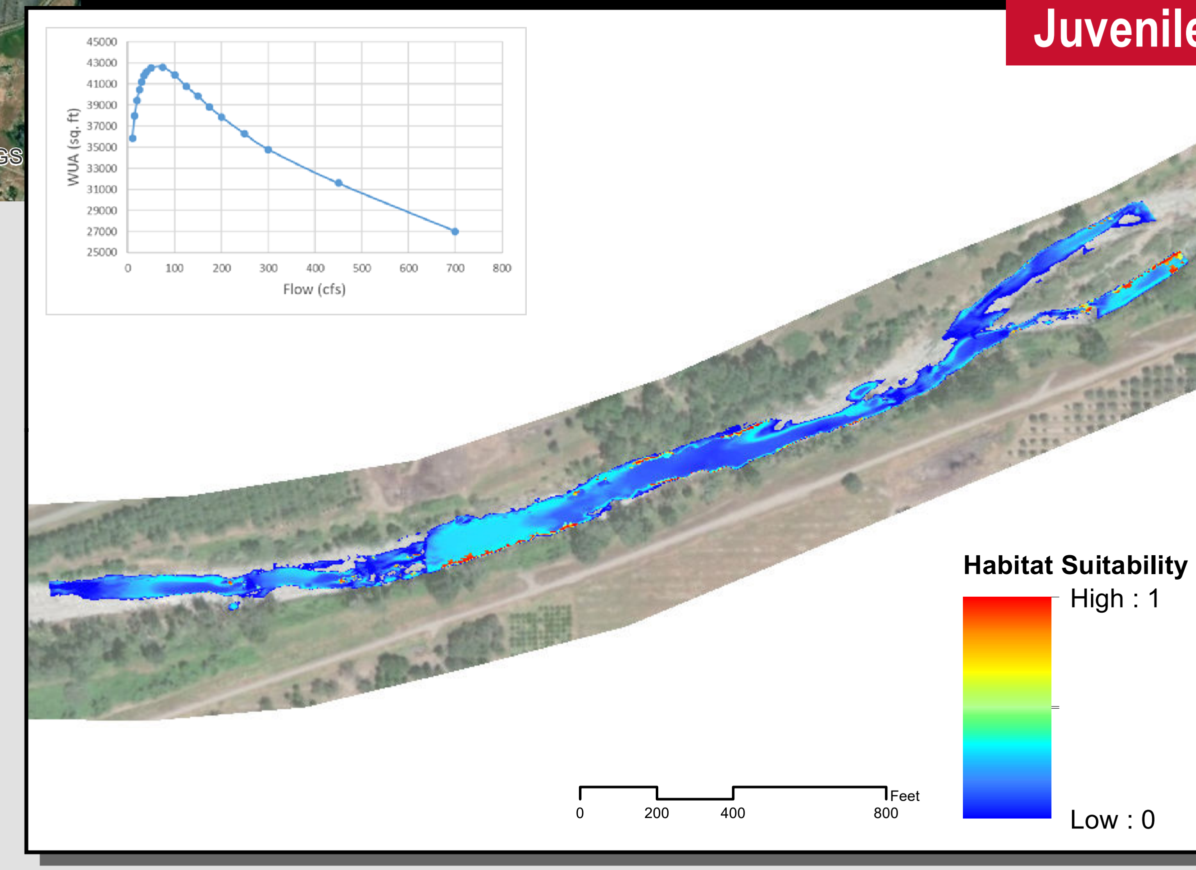
SSWD HDR

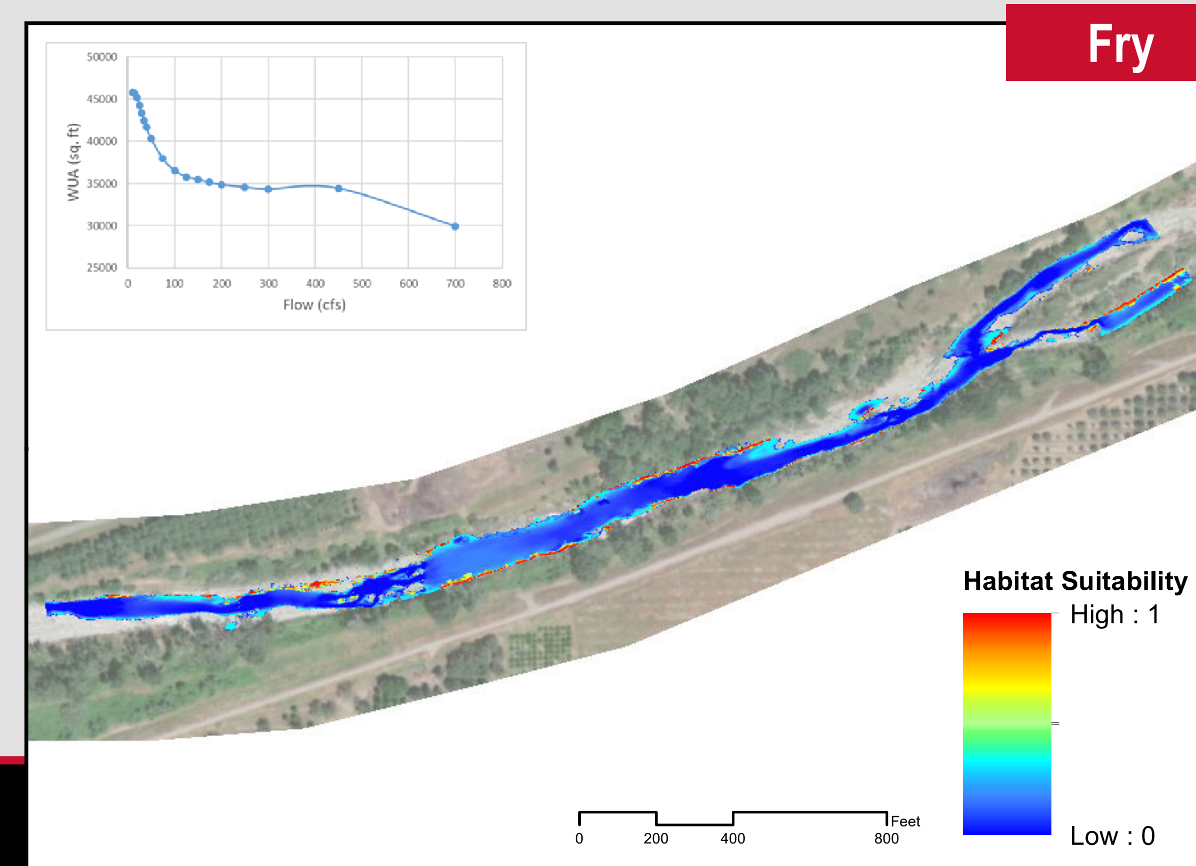
Fall-Run Chinook Salmon

Downstream Study Site 100 cfs

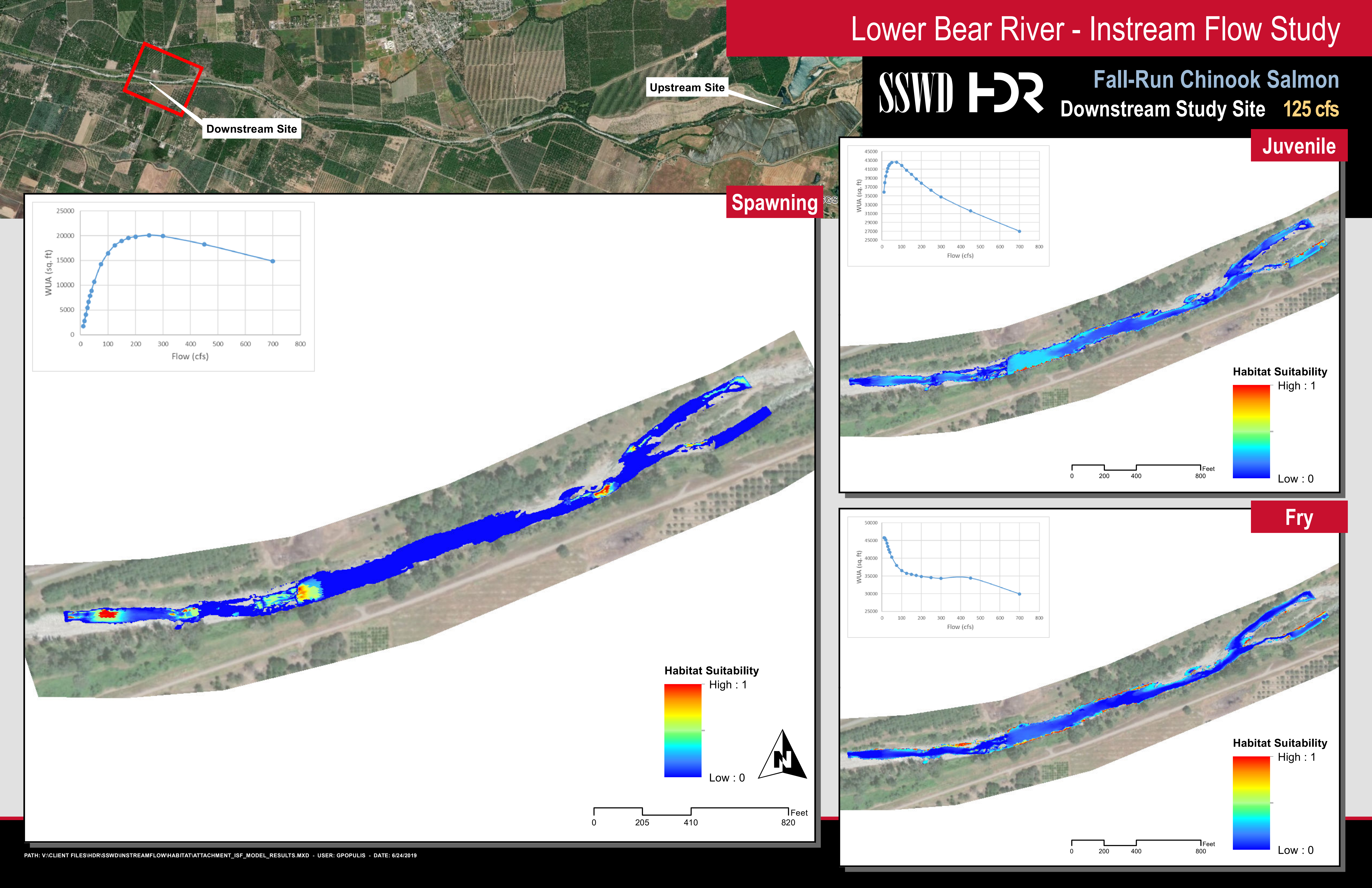








PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

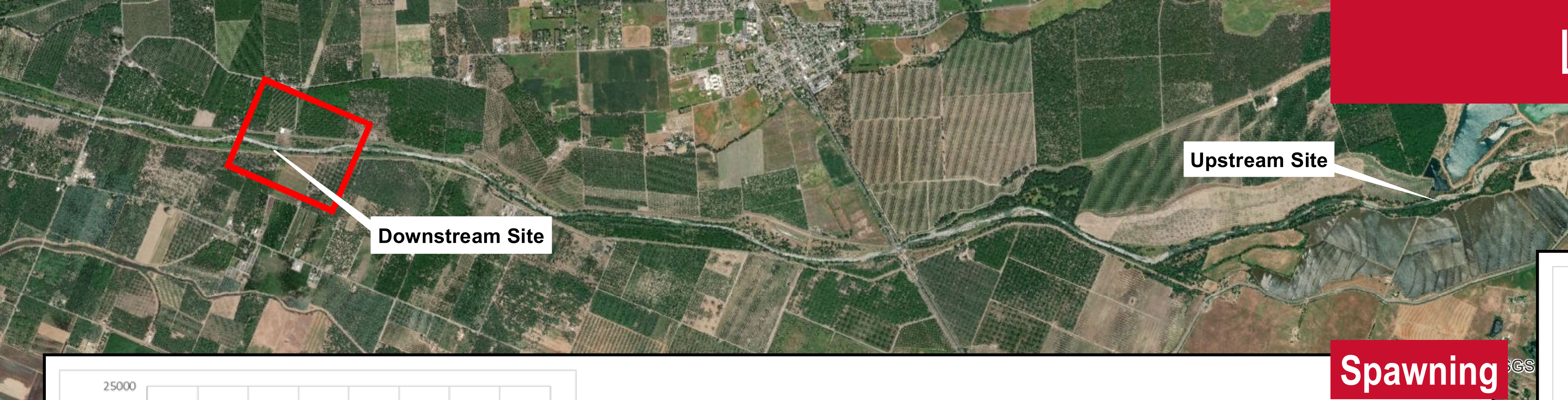

Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Downstream Study Site
125 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
N
Feet
0
205
410
820
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
200
400
800
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
200
400
800
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

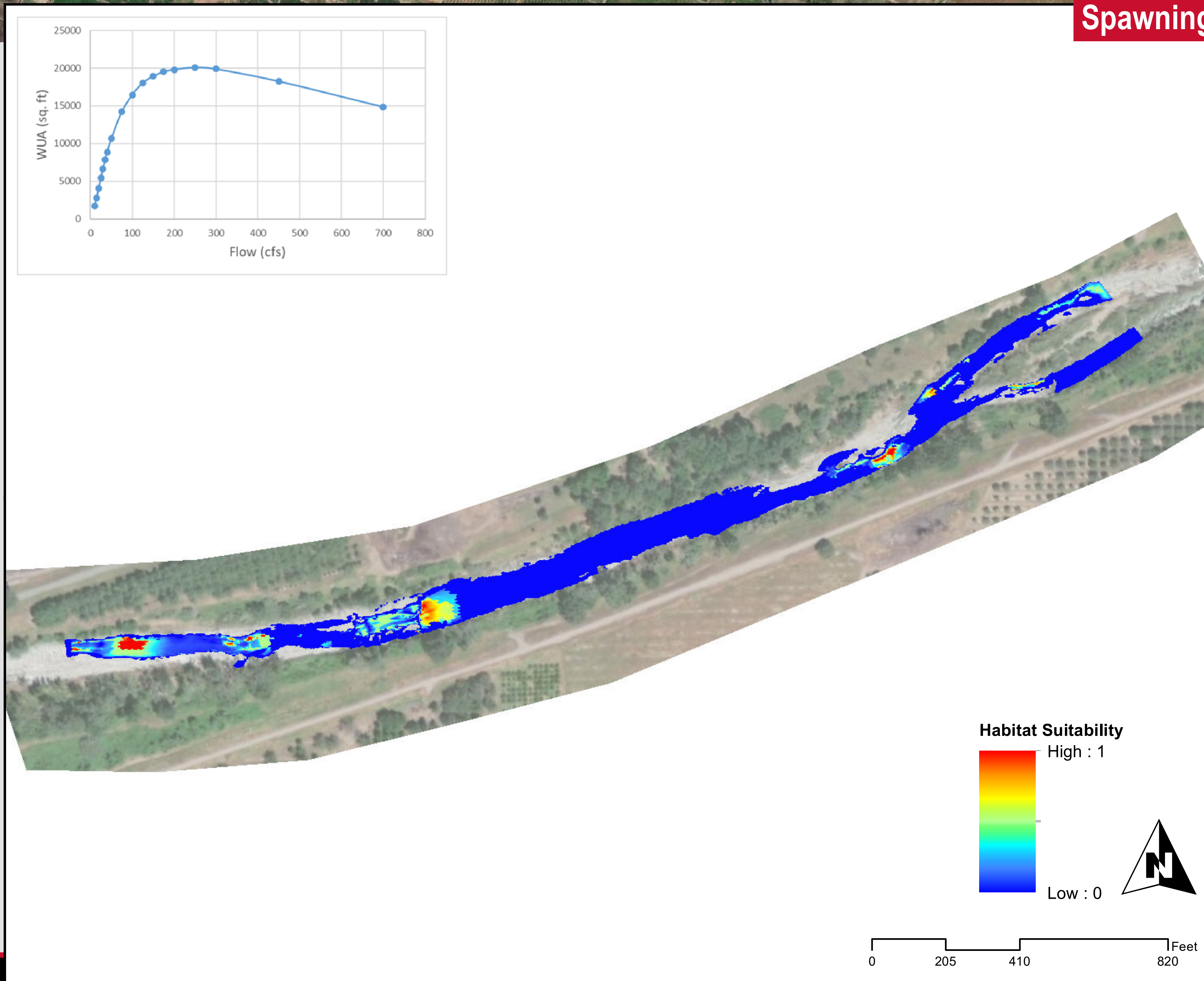
SSWD HDR

Fall-Run Chinook Salmon

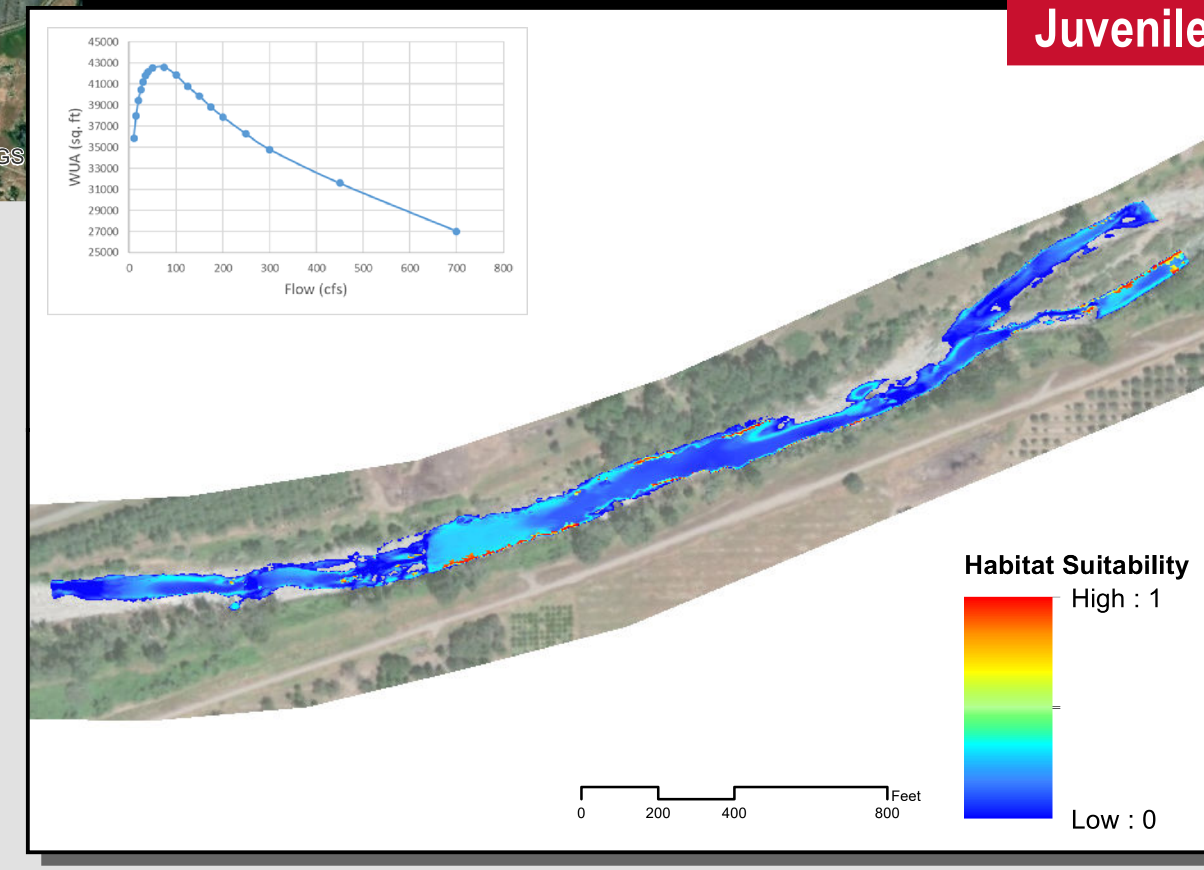
Downstream Study Site 150 cfs



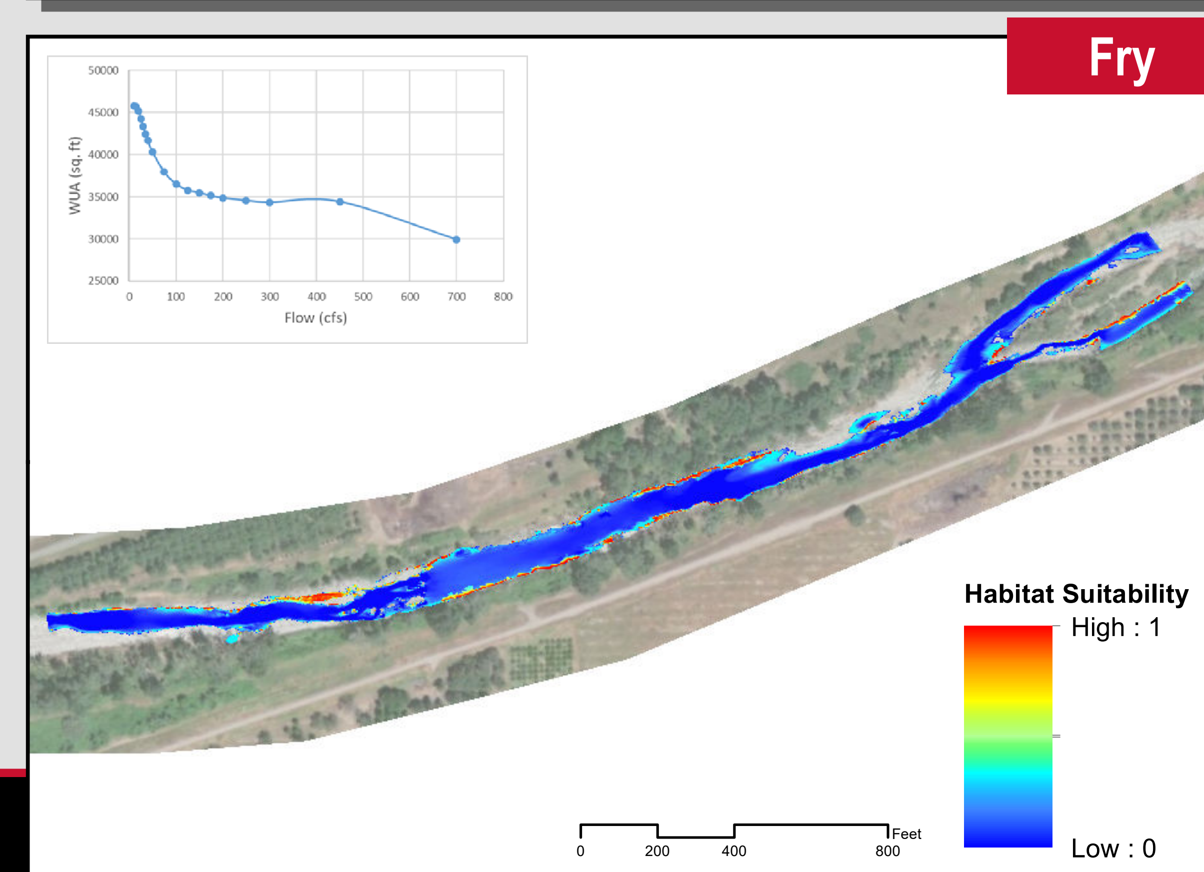
Spawning



Juvenile



Fry

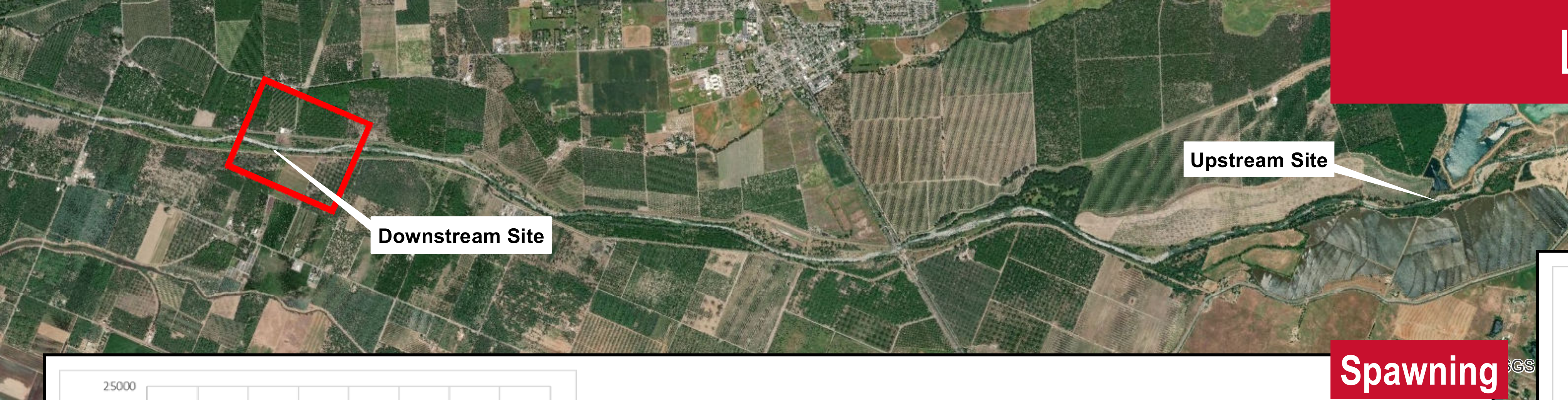


PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

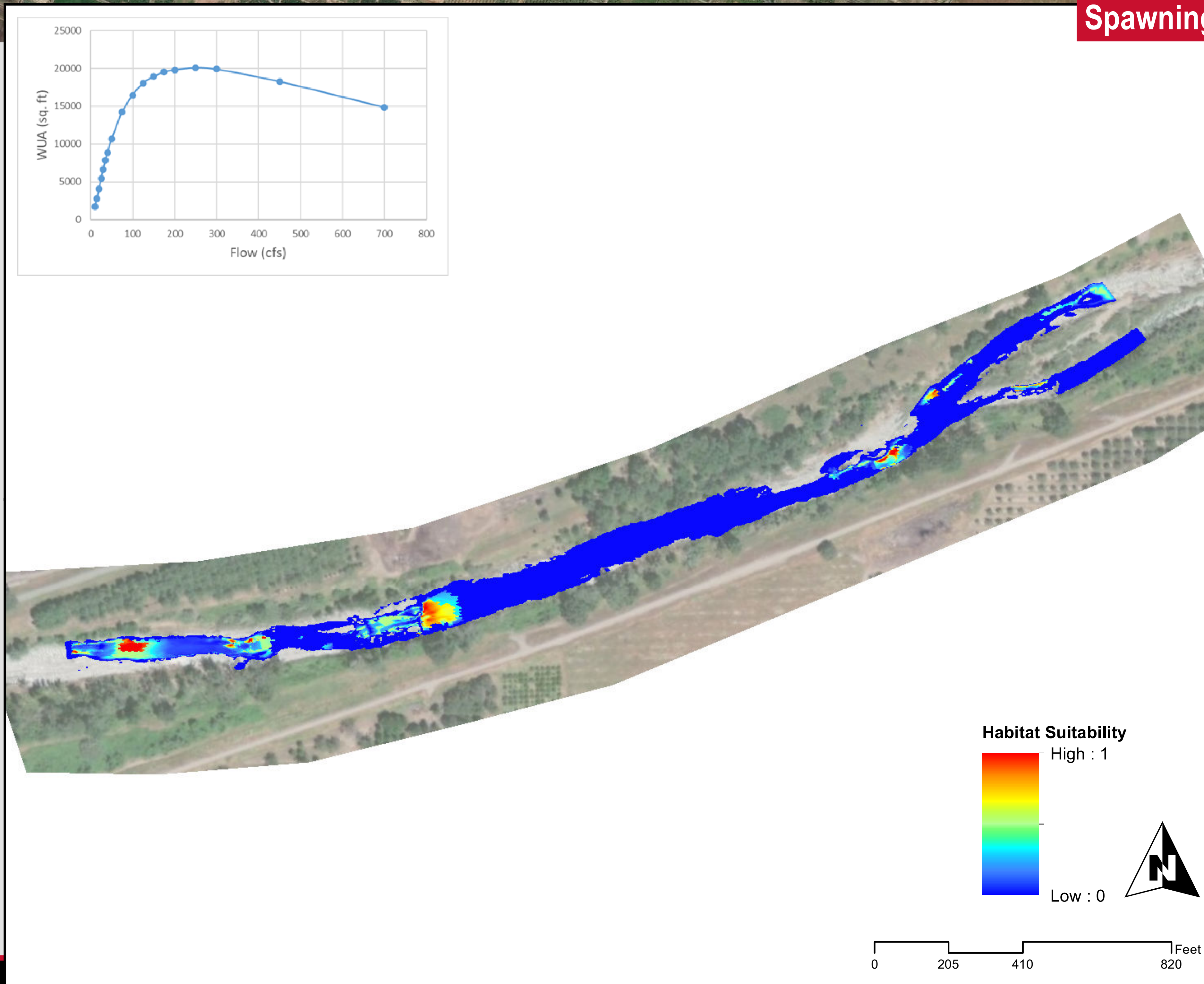
Lower Bear River - Instream Flow Study

Fall-Run Chinook Salmon

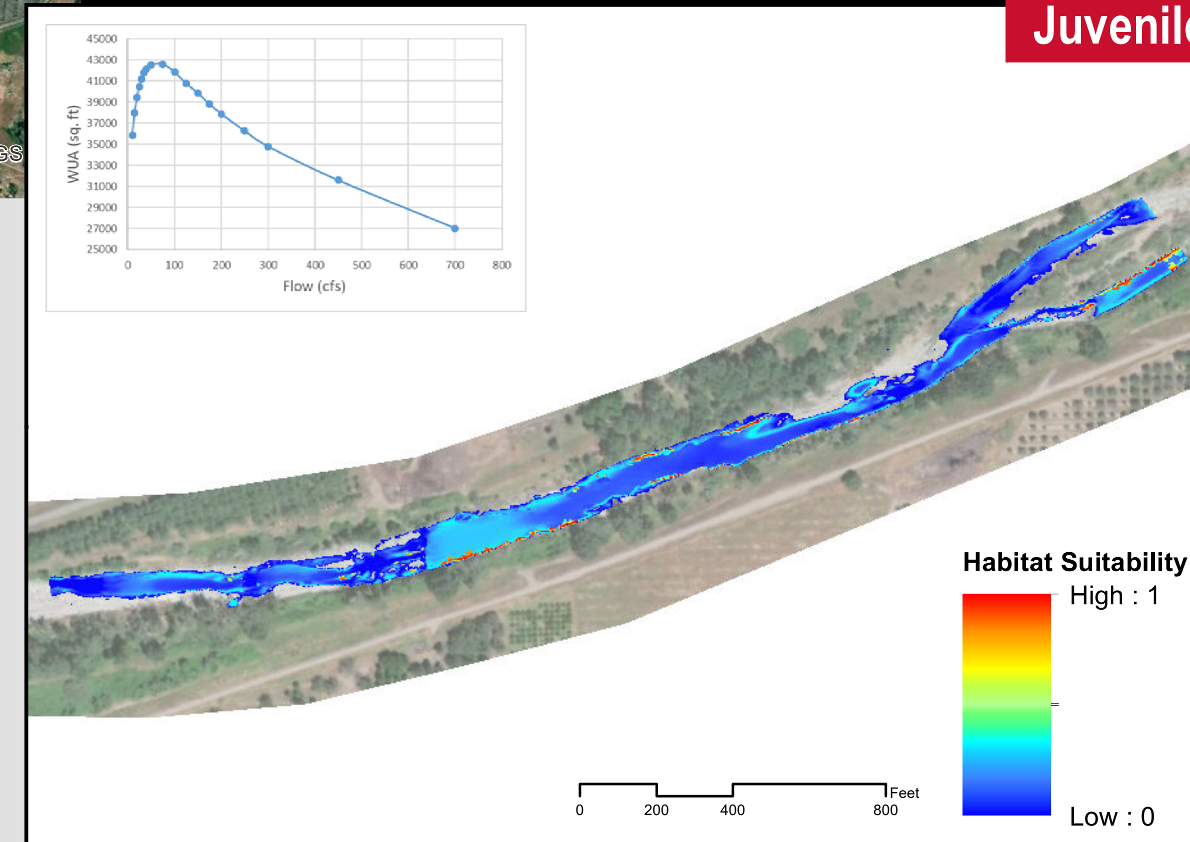
Downstream Study Site 175 cfs



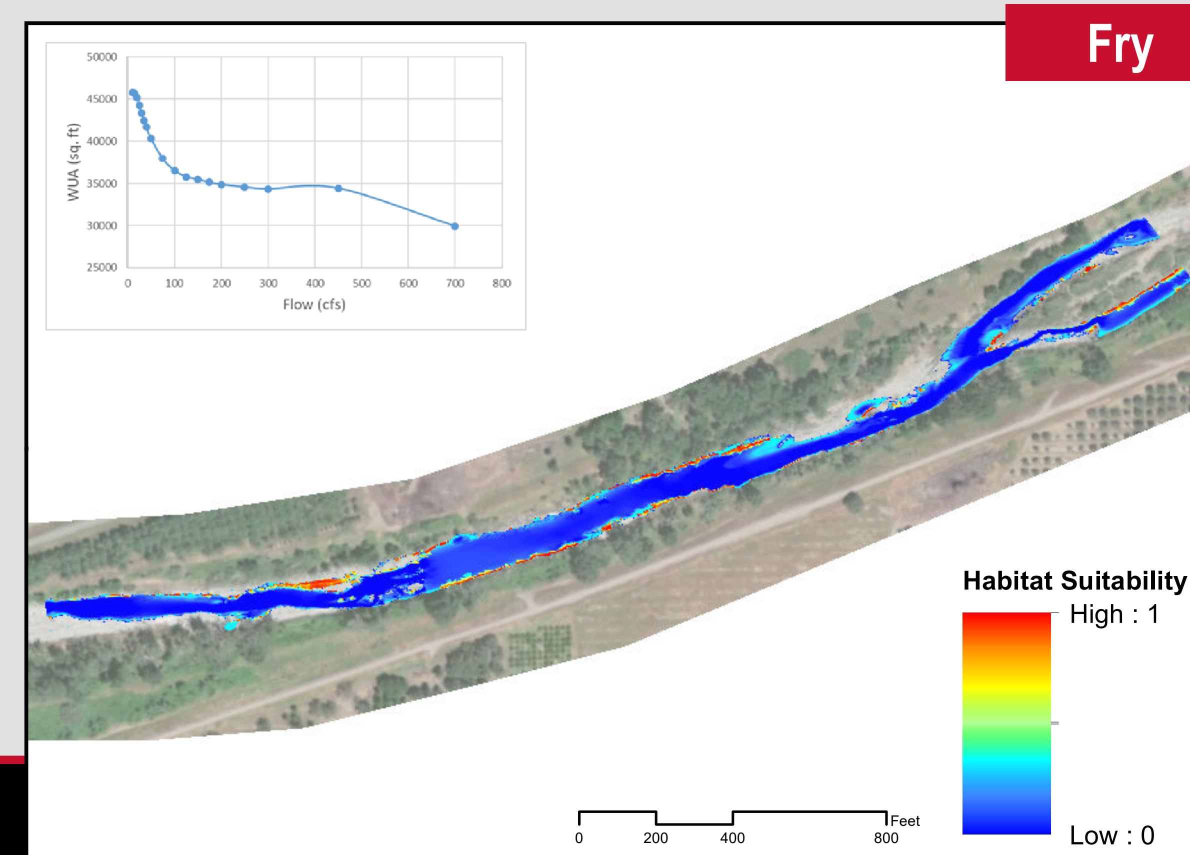
Spawning

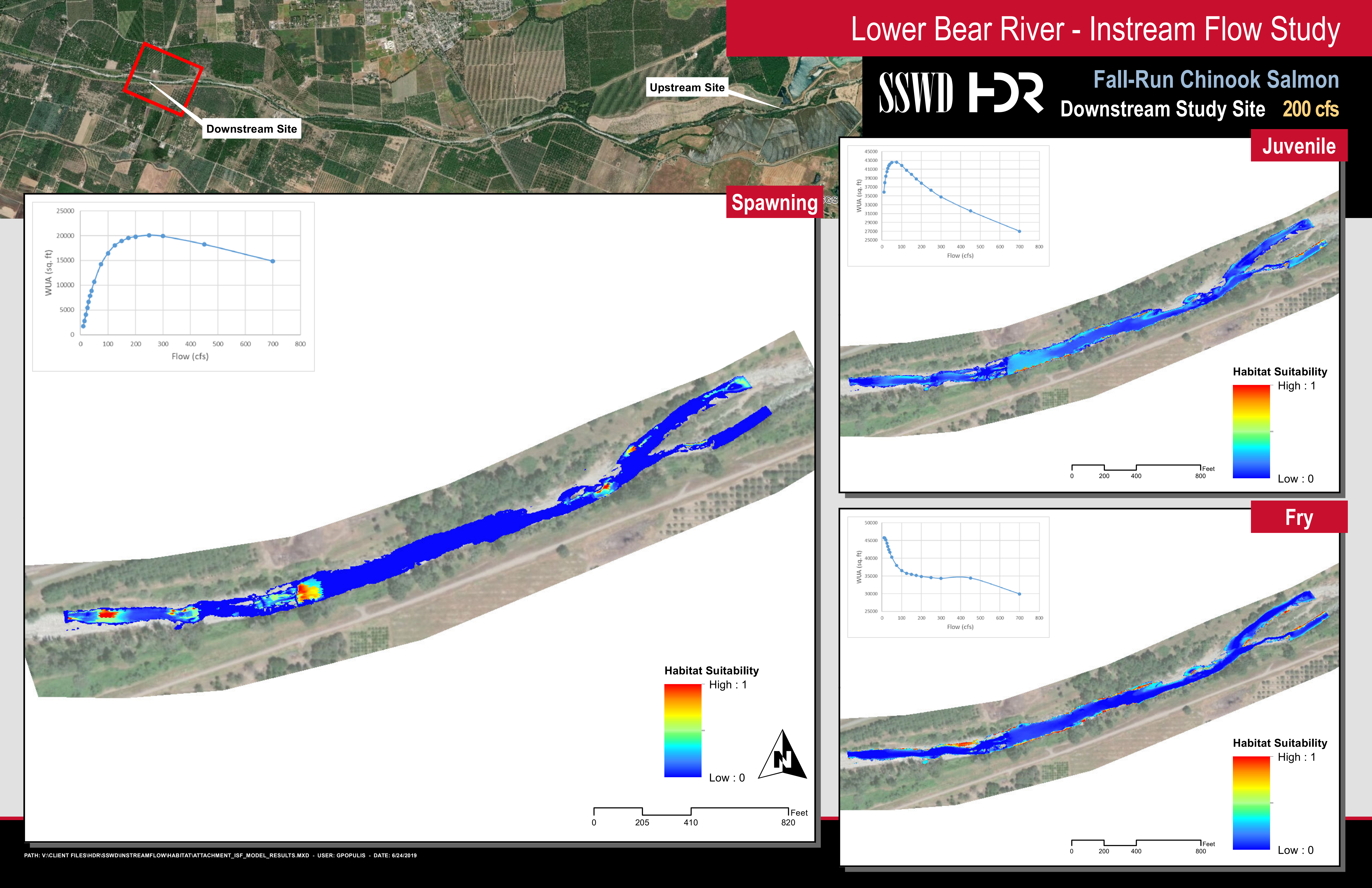


Juvenile



Fry



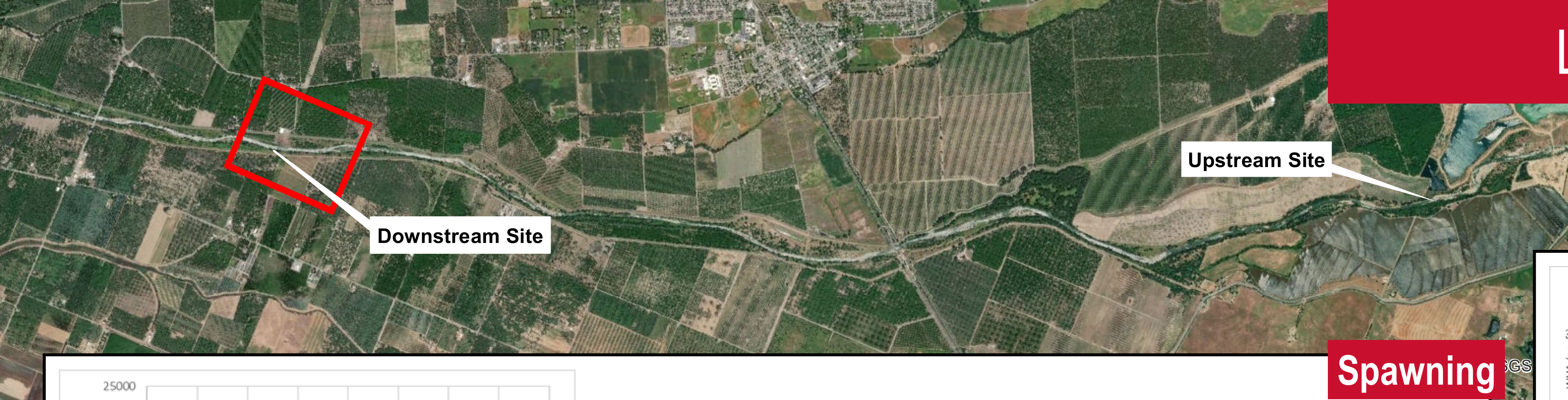


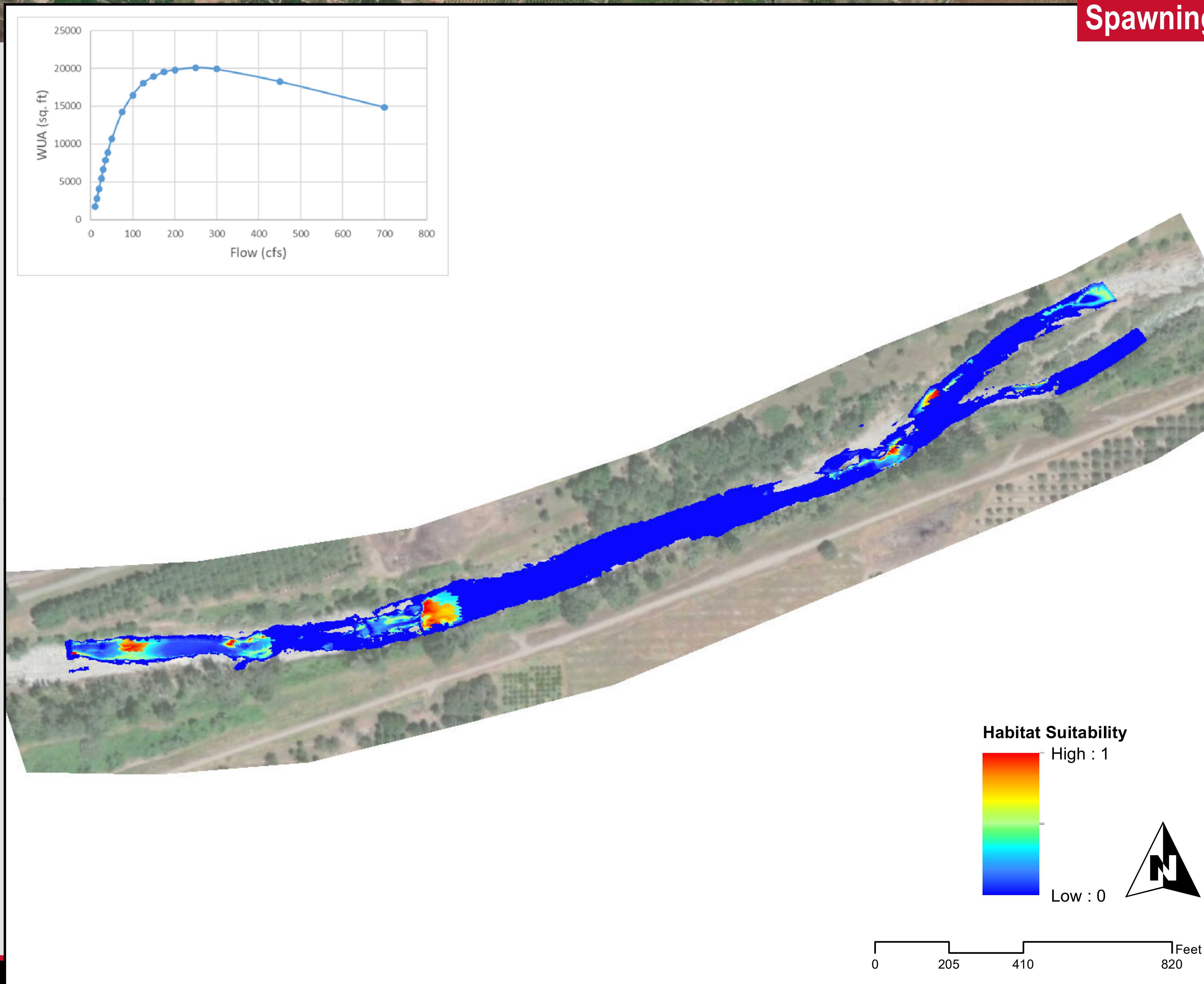
Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Downstream Study Site
200 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
25000
20000
15000
10000
5000
0
0
100
200
300
400
500
600
700
800
Habitat Suitability
High : 1
Low : 0
N
0
205
410
820
Feet
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
200
400
800
Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
200
400
800
Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

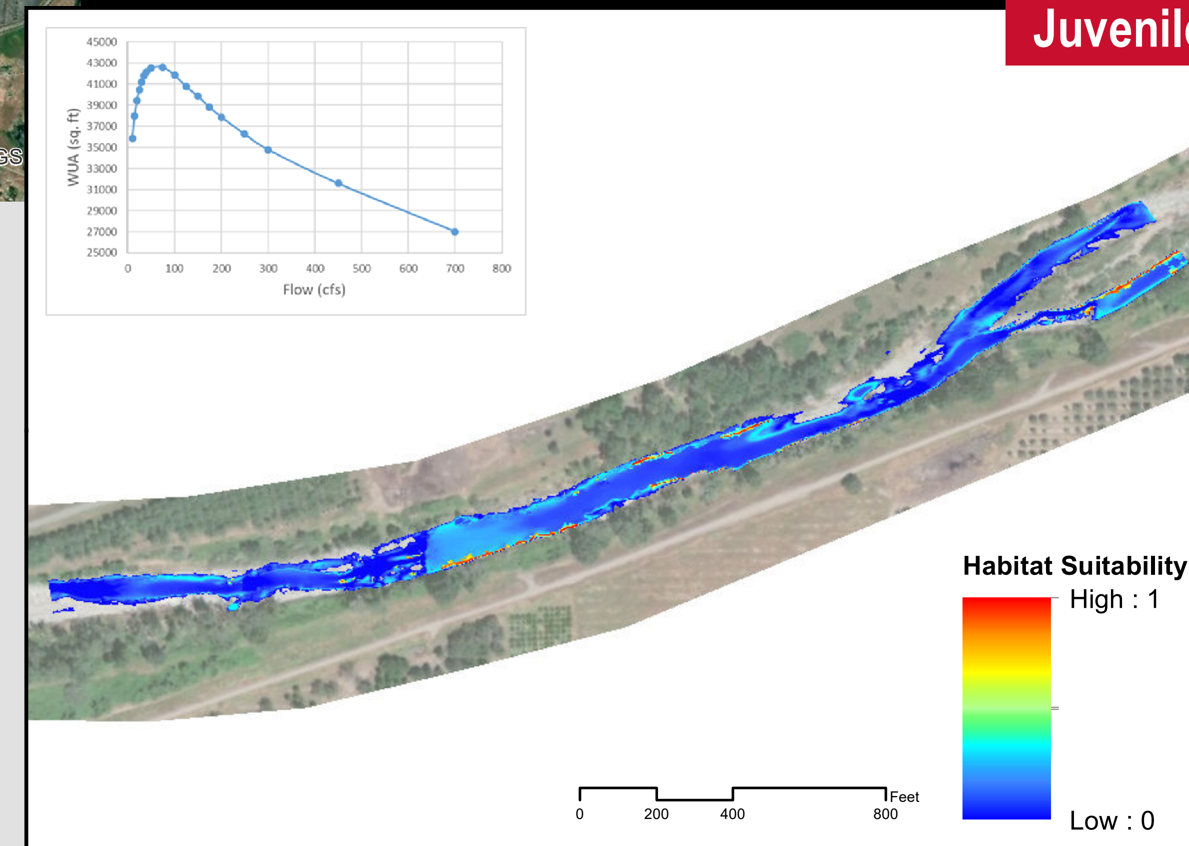
Lower Bear River - Instream Flow Study

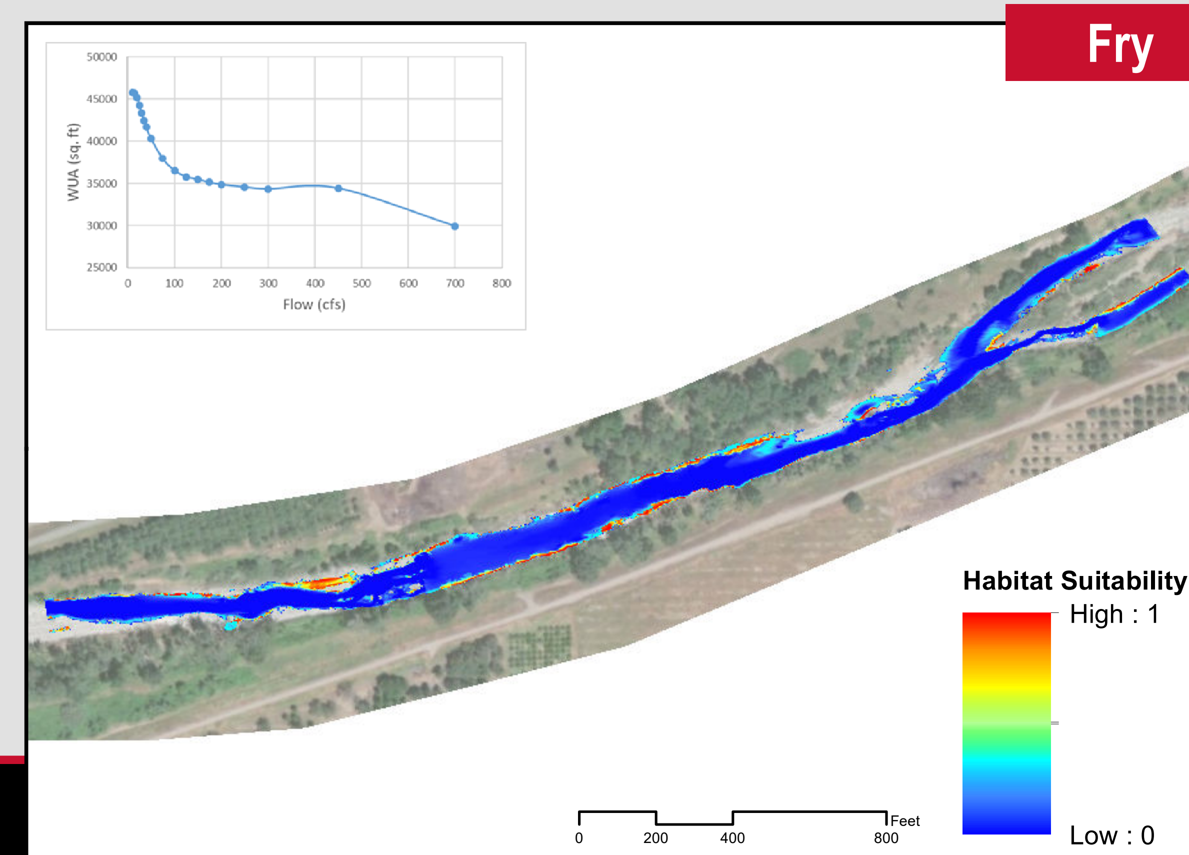
Fall-Run Chinook Salmon

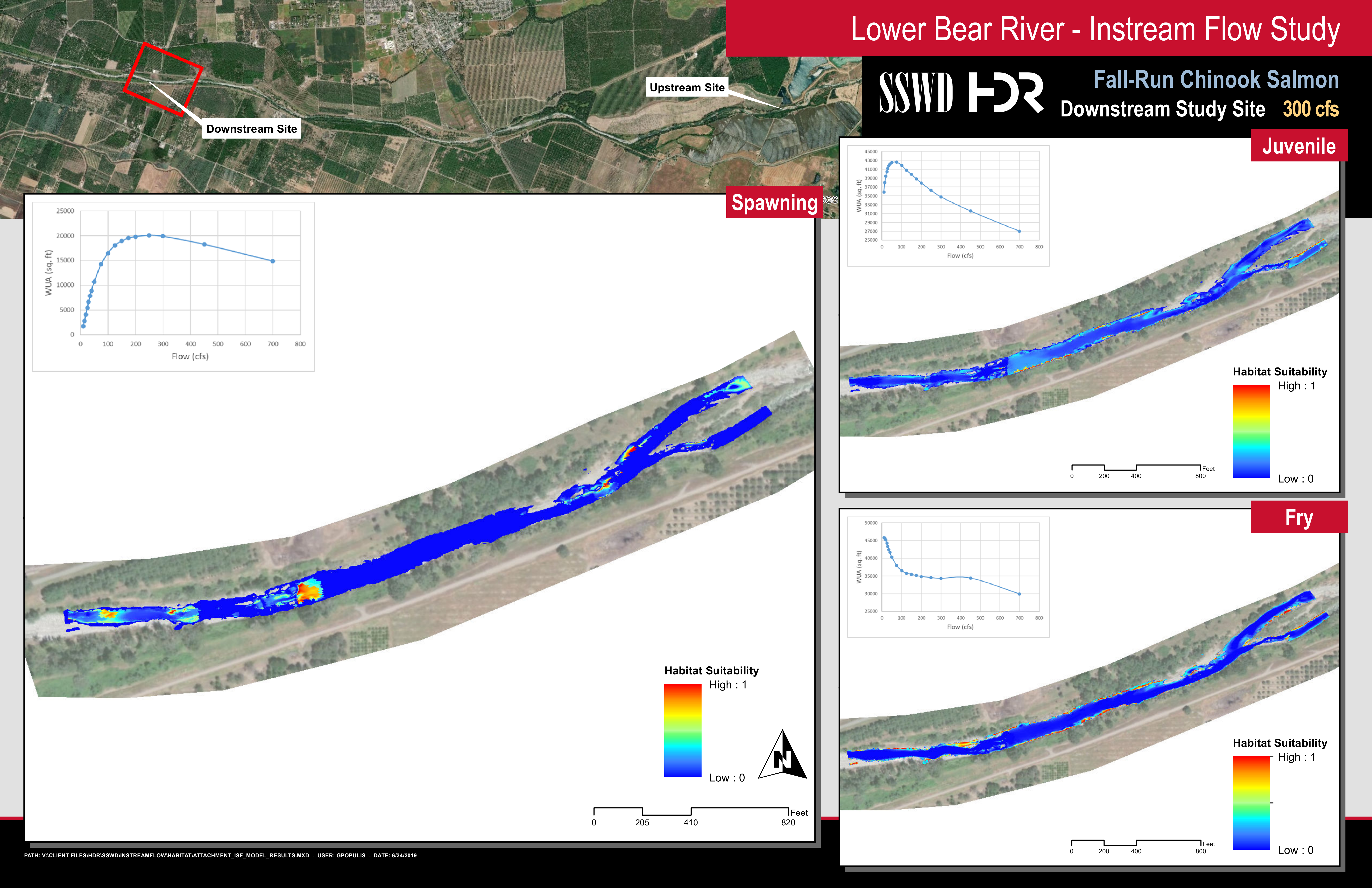
Downstream Study Site 250 cfs









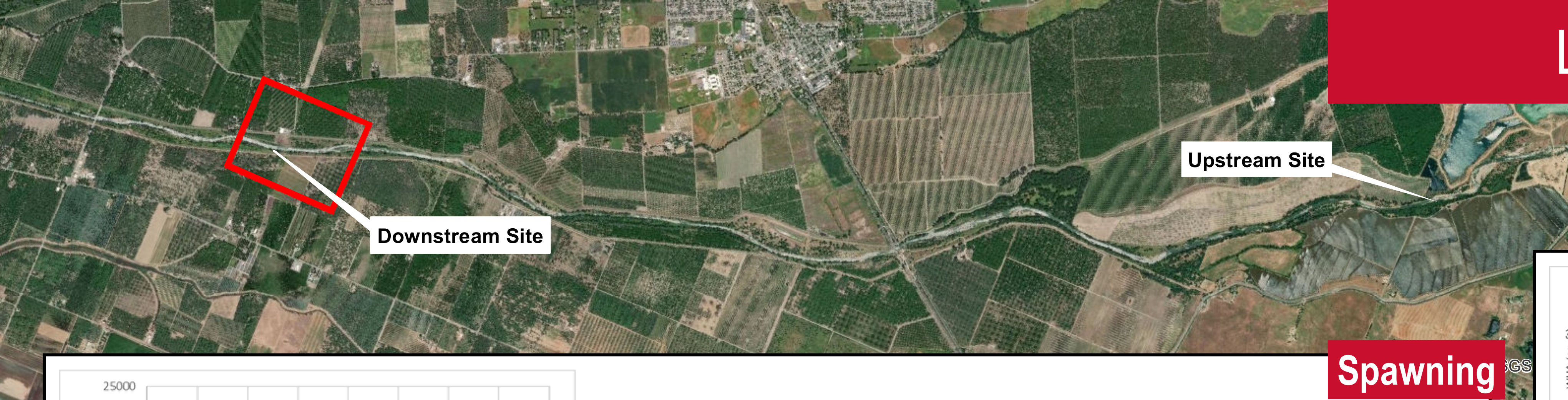

Lower Bear River - Instream Flow Study
SSWD
HDR
Fall-Run Chinook Salmon
Downstream Study Site
300 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
N
Feet
0
205
410
820
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
200
400
800
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
200
400
800
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

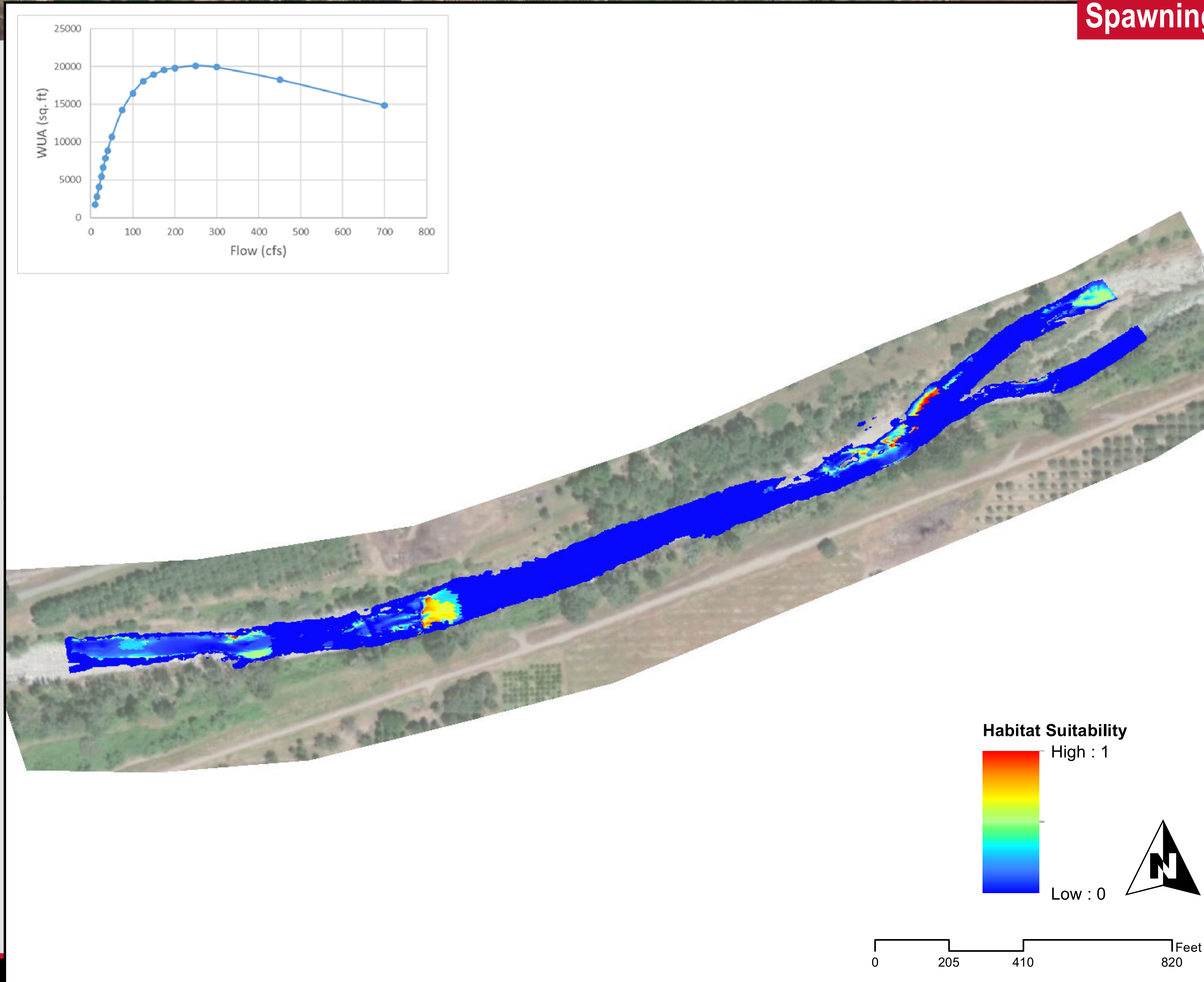
SSWD HDR

Fall-Run Chinook Salmon

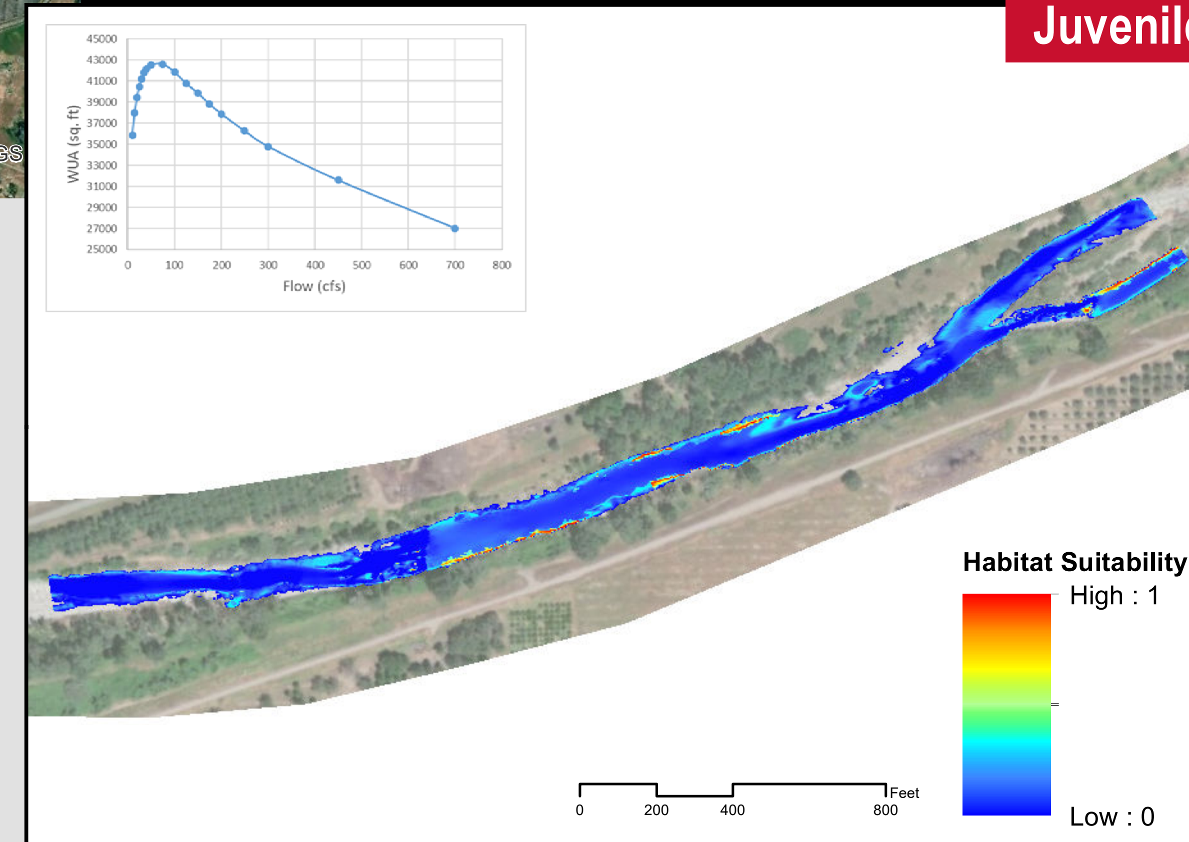
Downstream Study Site 450 cfs



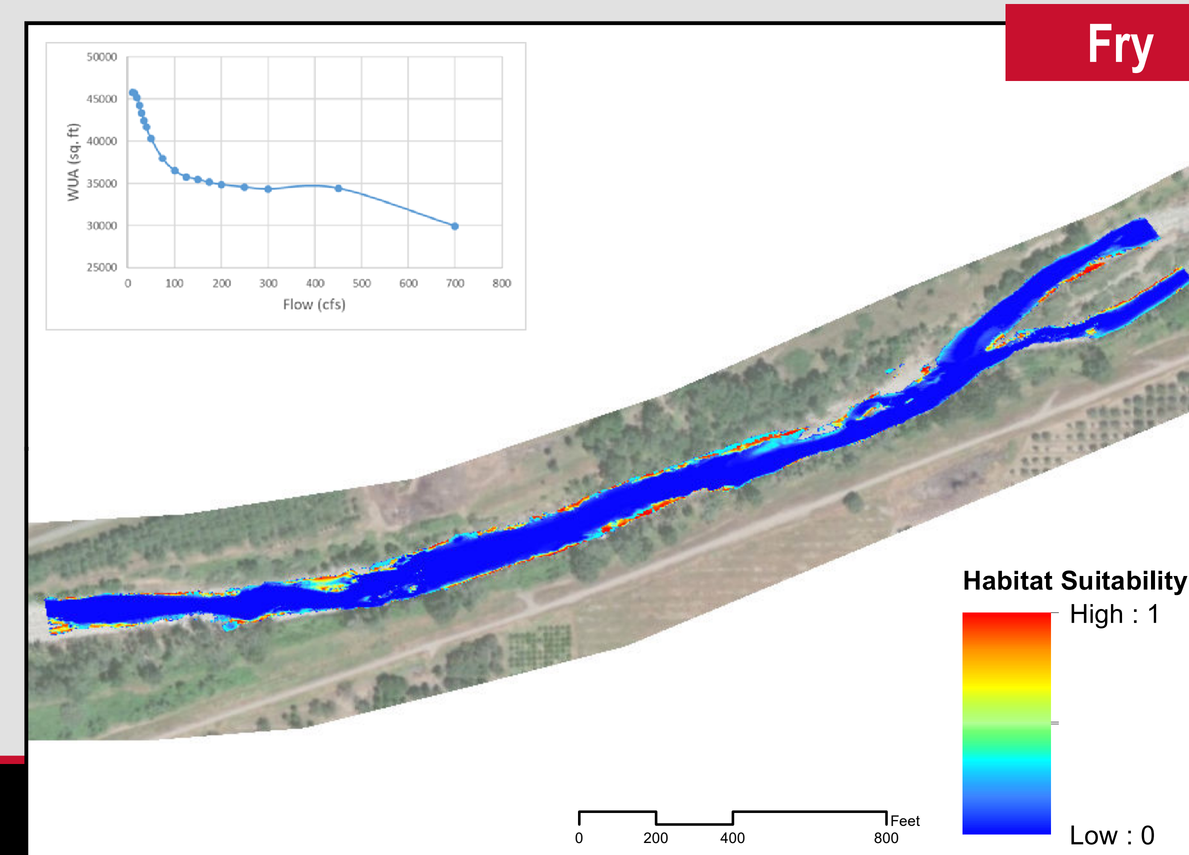
Spawning



Juvenile



Fry



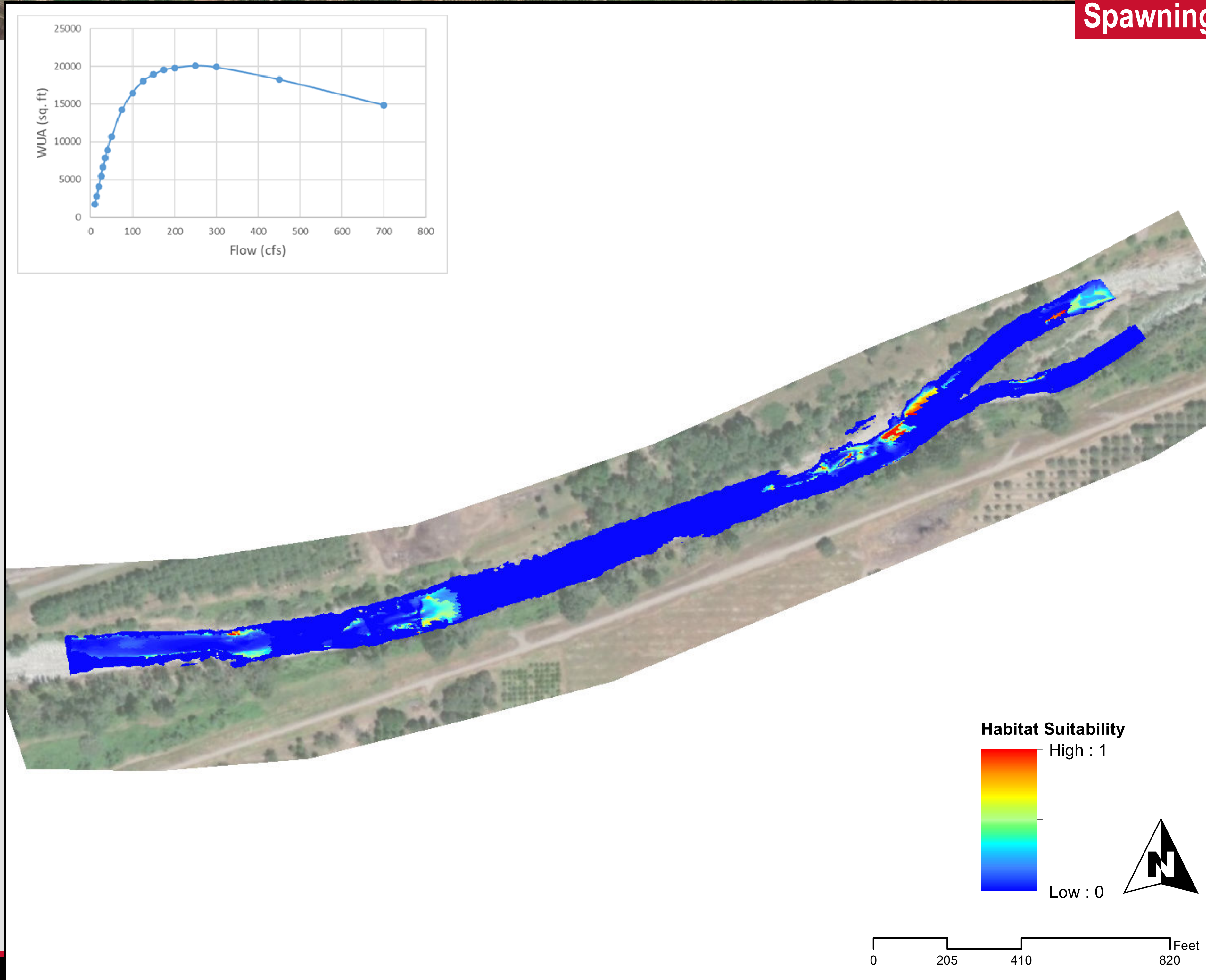
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

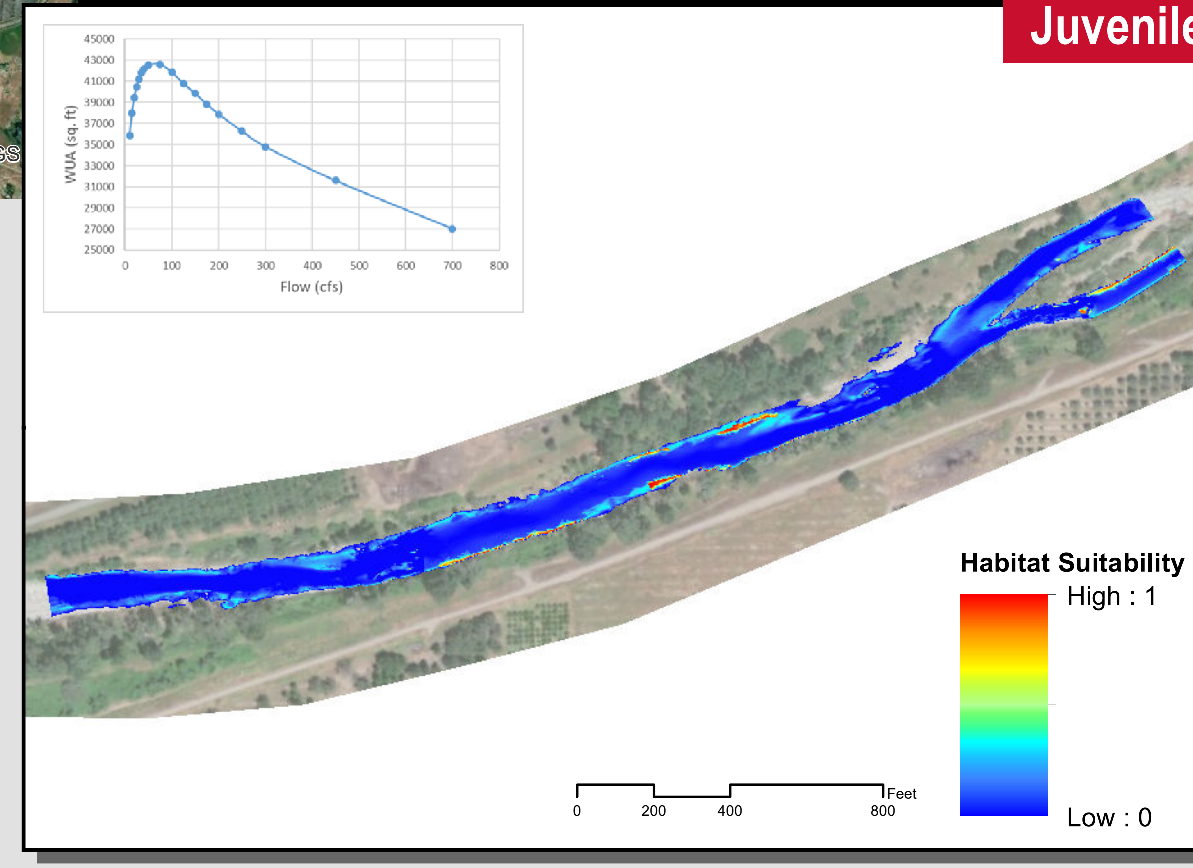
Fall-Run Chinook Salmon

Downstream Study Site 700 cfs

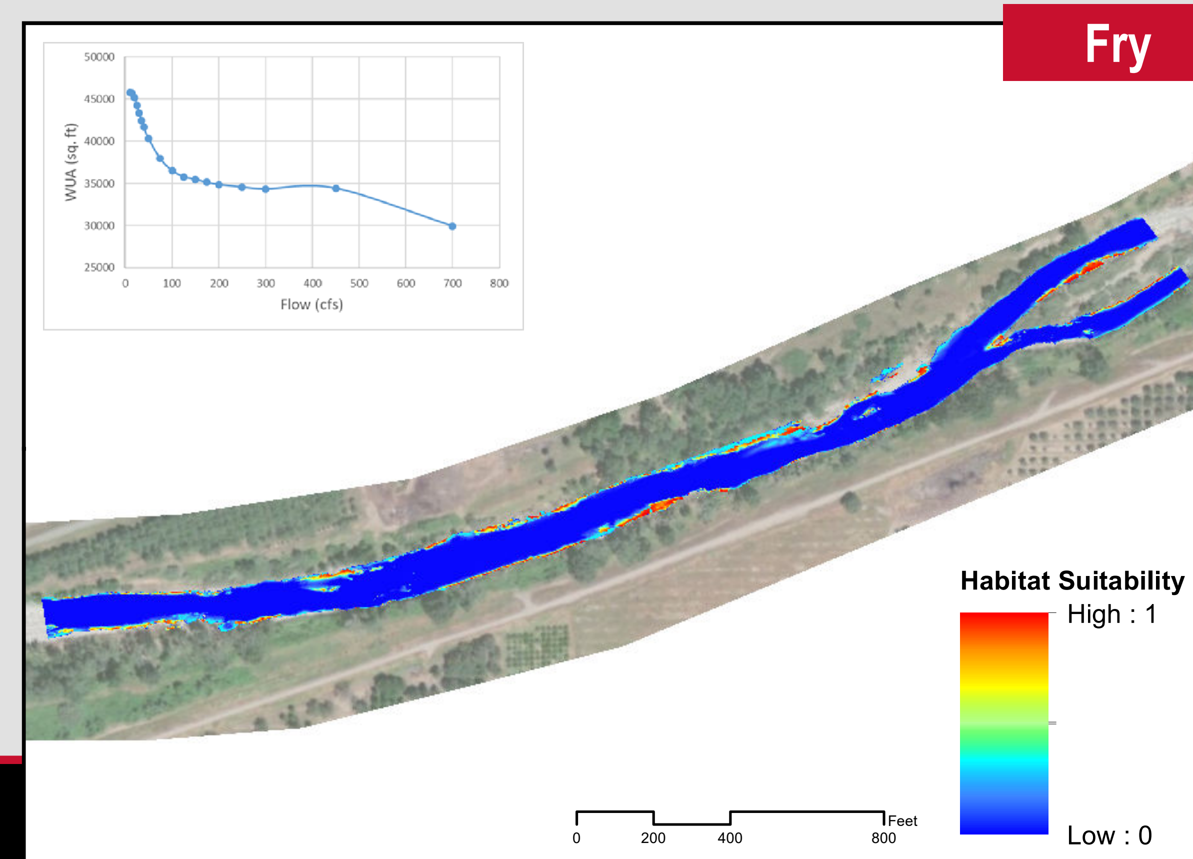
Spawning



Juvenile



Fry

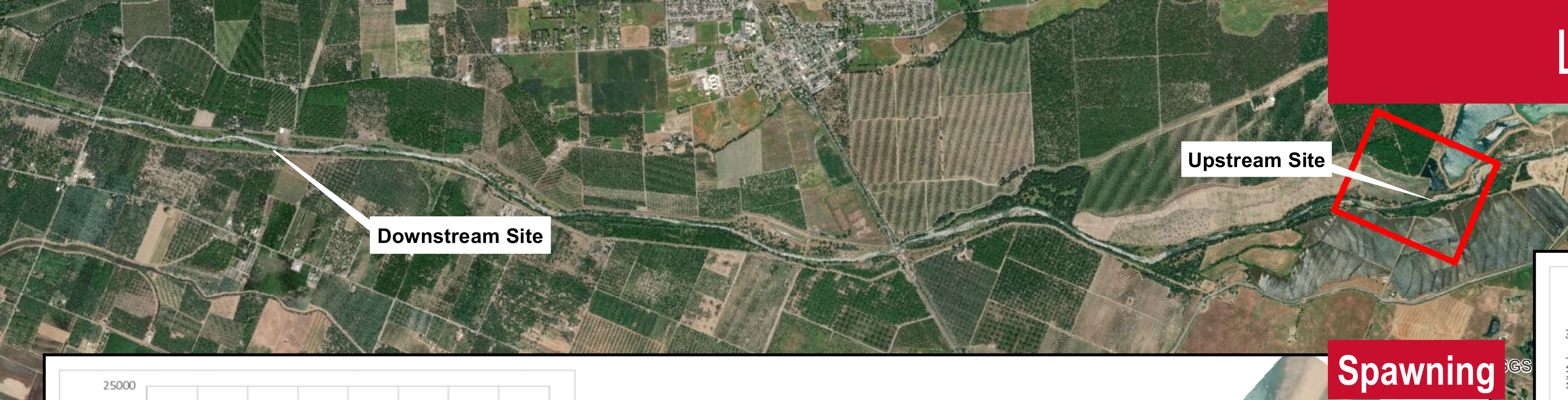


PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

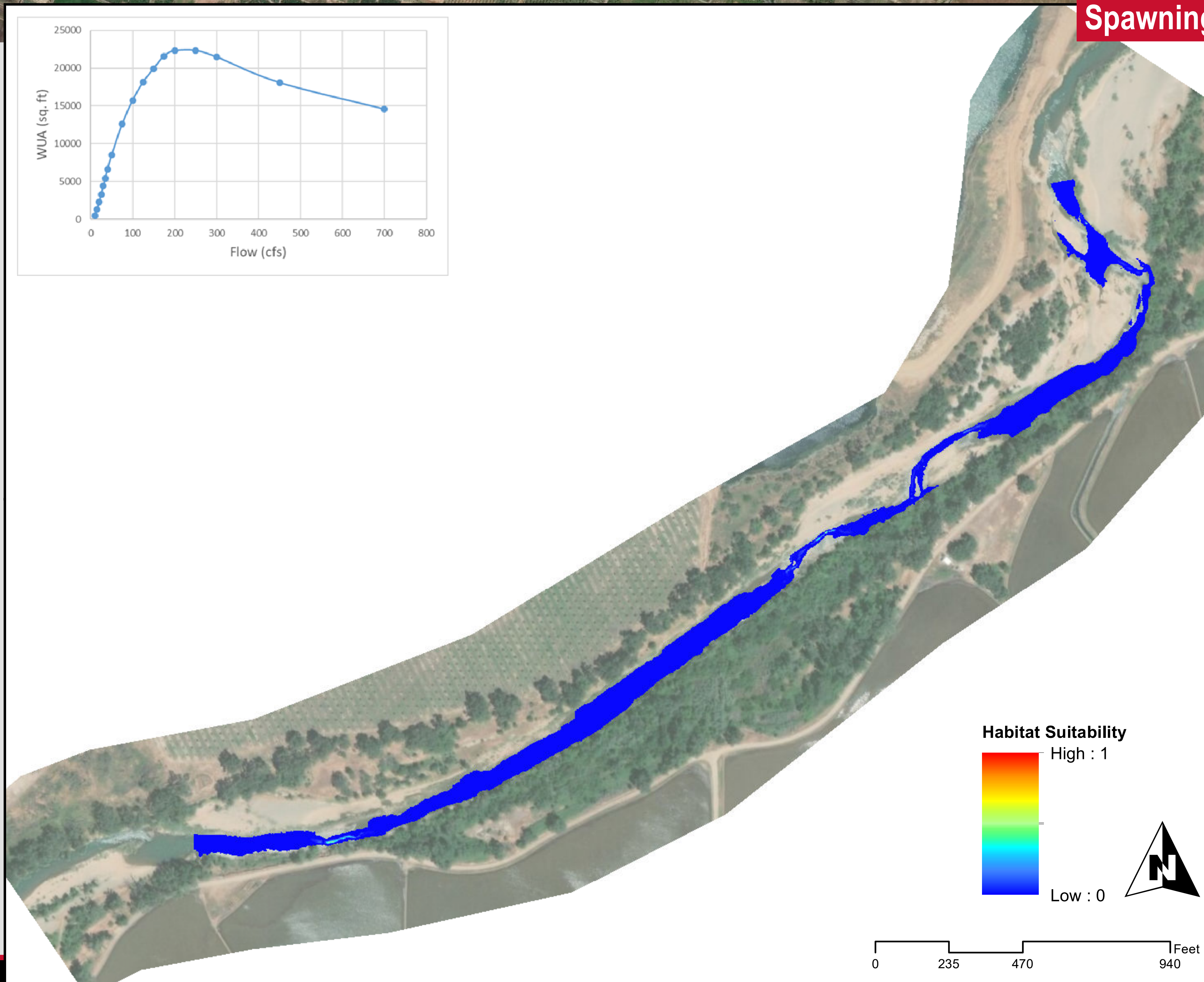
Lower Bear River - Instream Flow Study

Steelhead

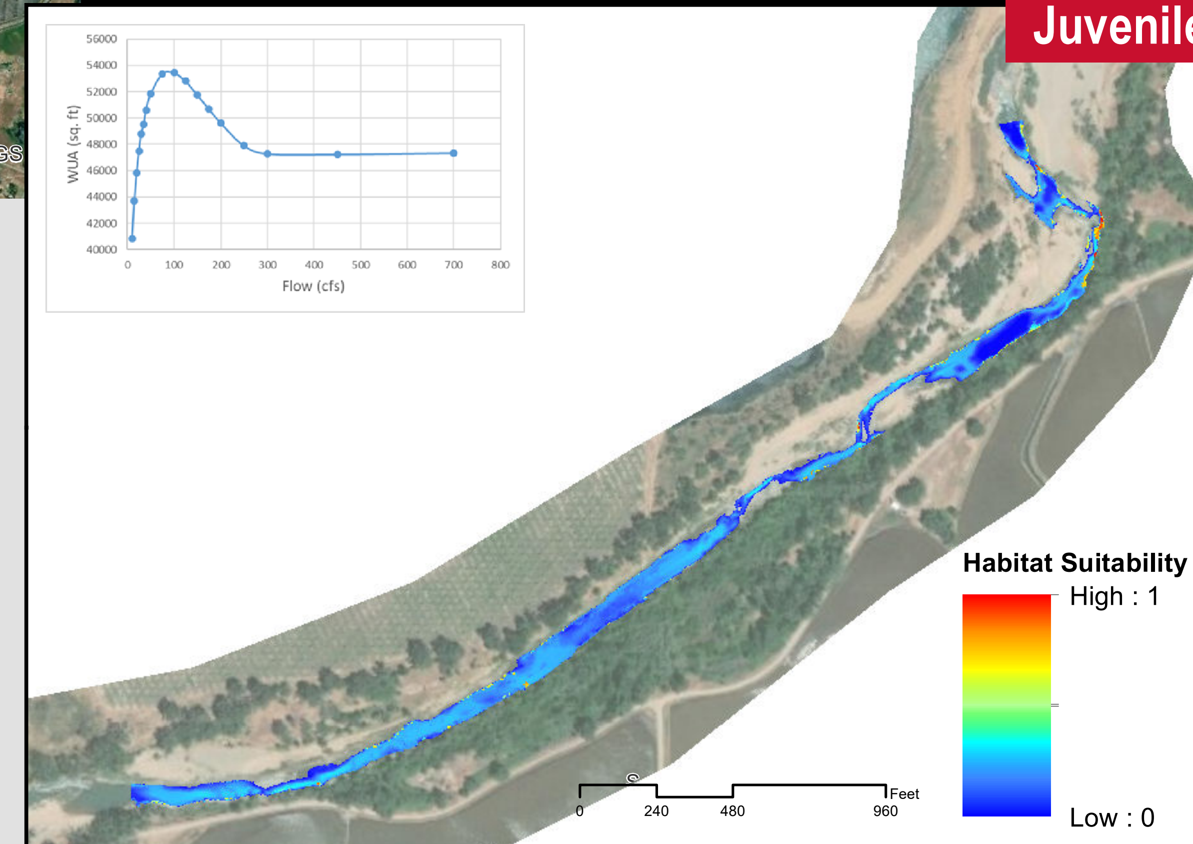
Upstream Study Site 10 cfs



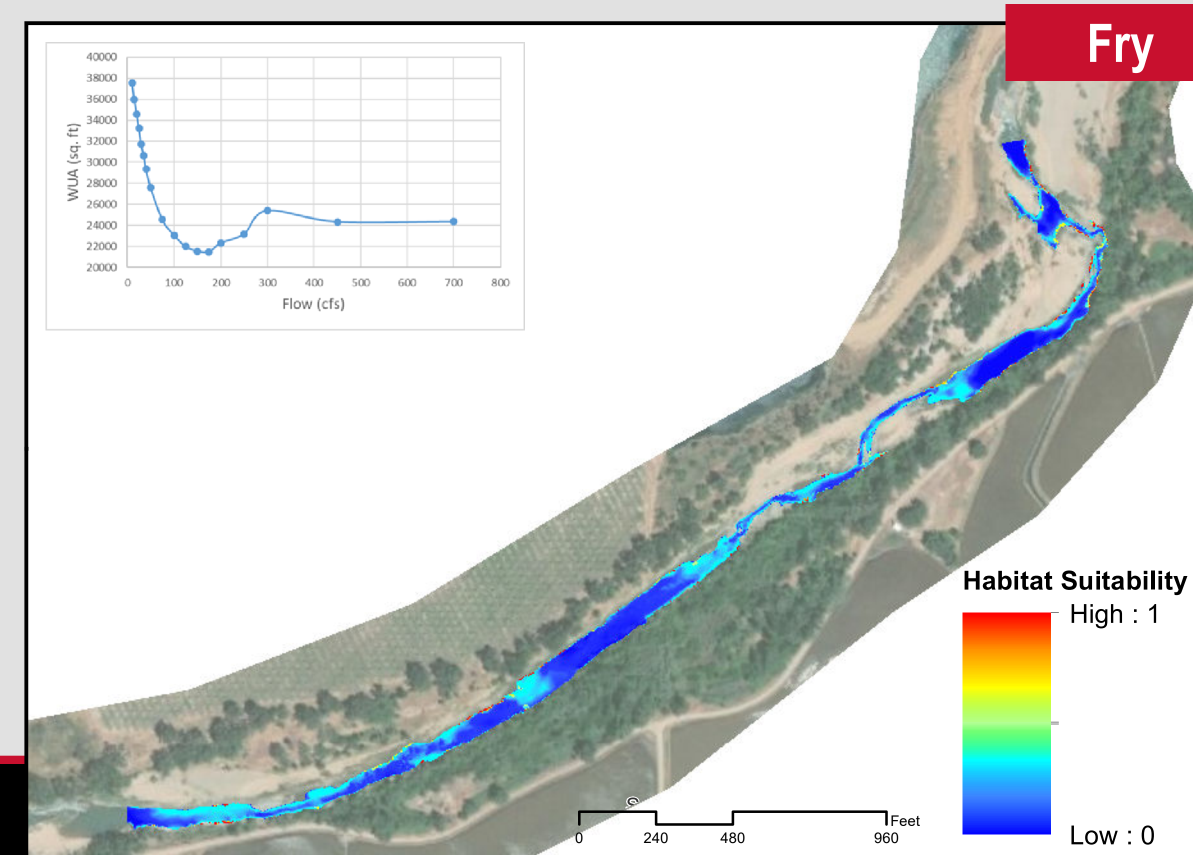
Spawning



Juvenile



Fry

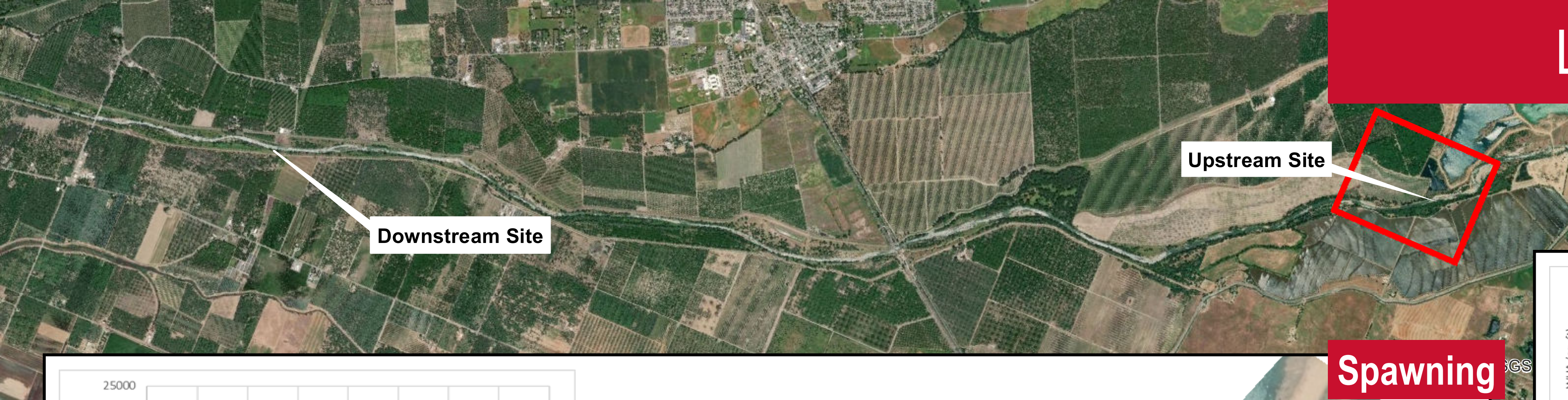


Lower Bear River - Instream Flow Study

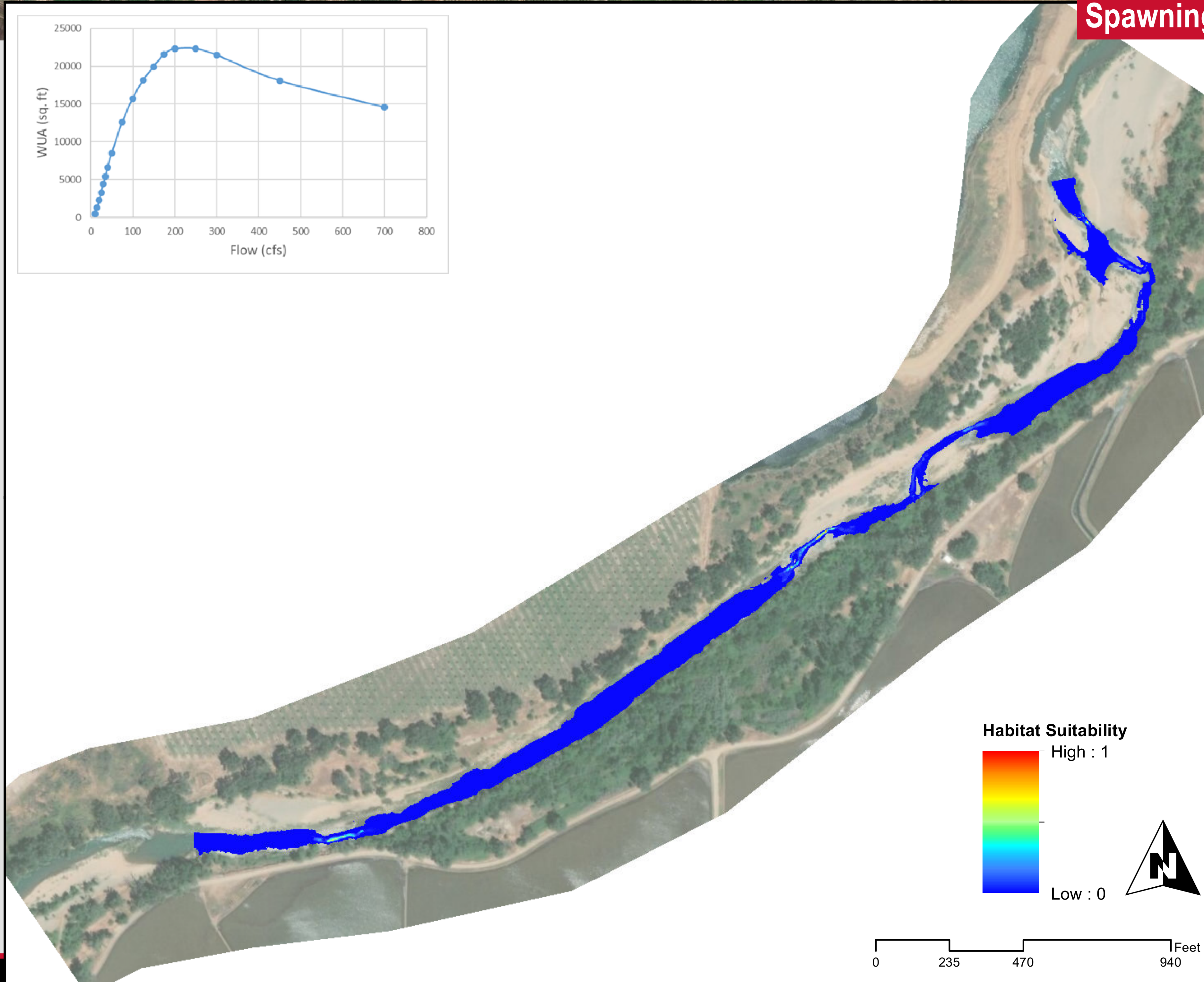
SSWD HDR

Steelhead

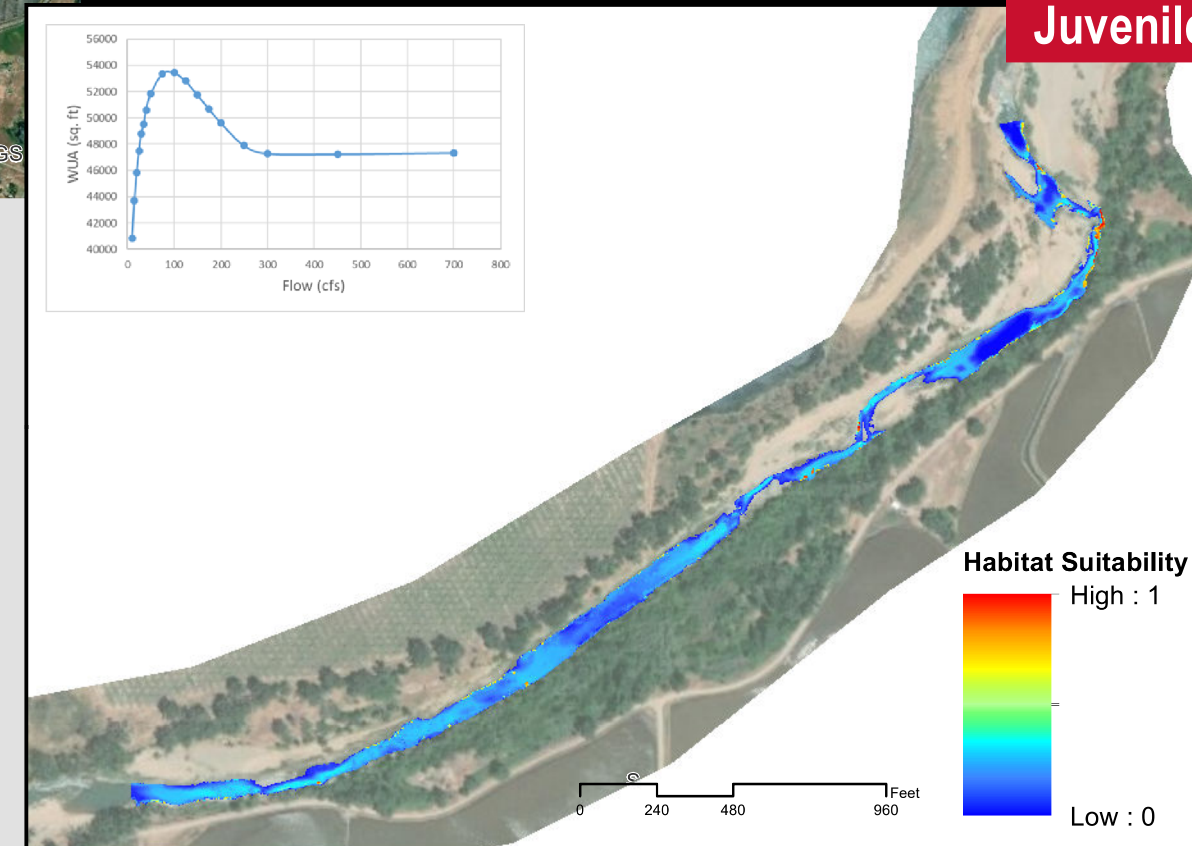
Upstream Study Site **15 cfs**



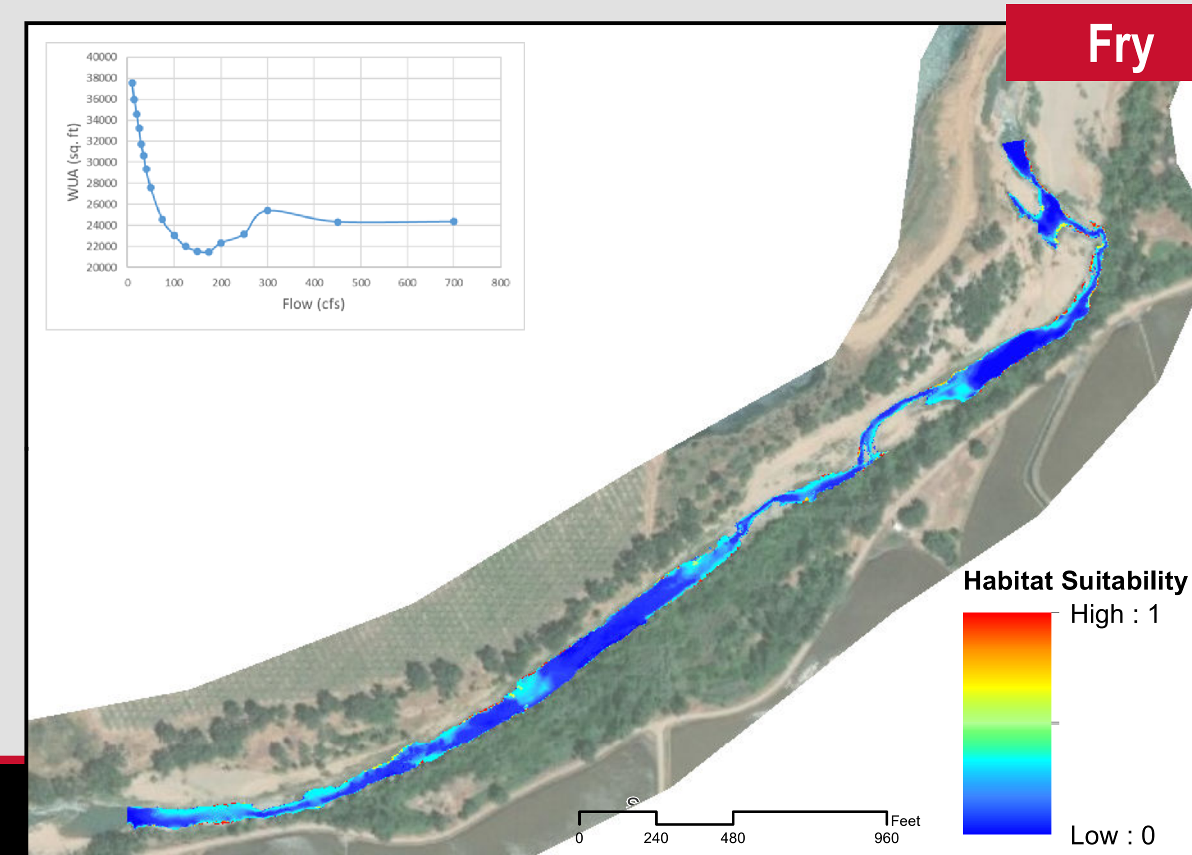
Spawning



Juvenile



Fry

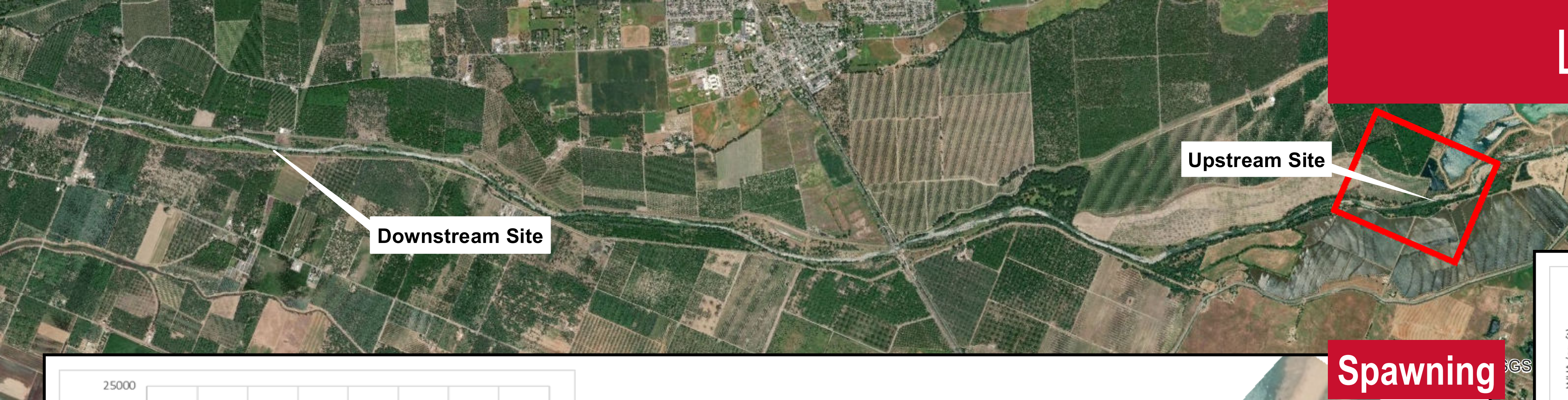


Lower Bear River - Instream Flow Study

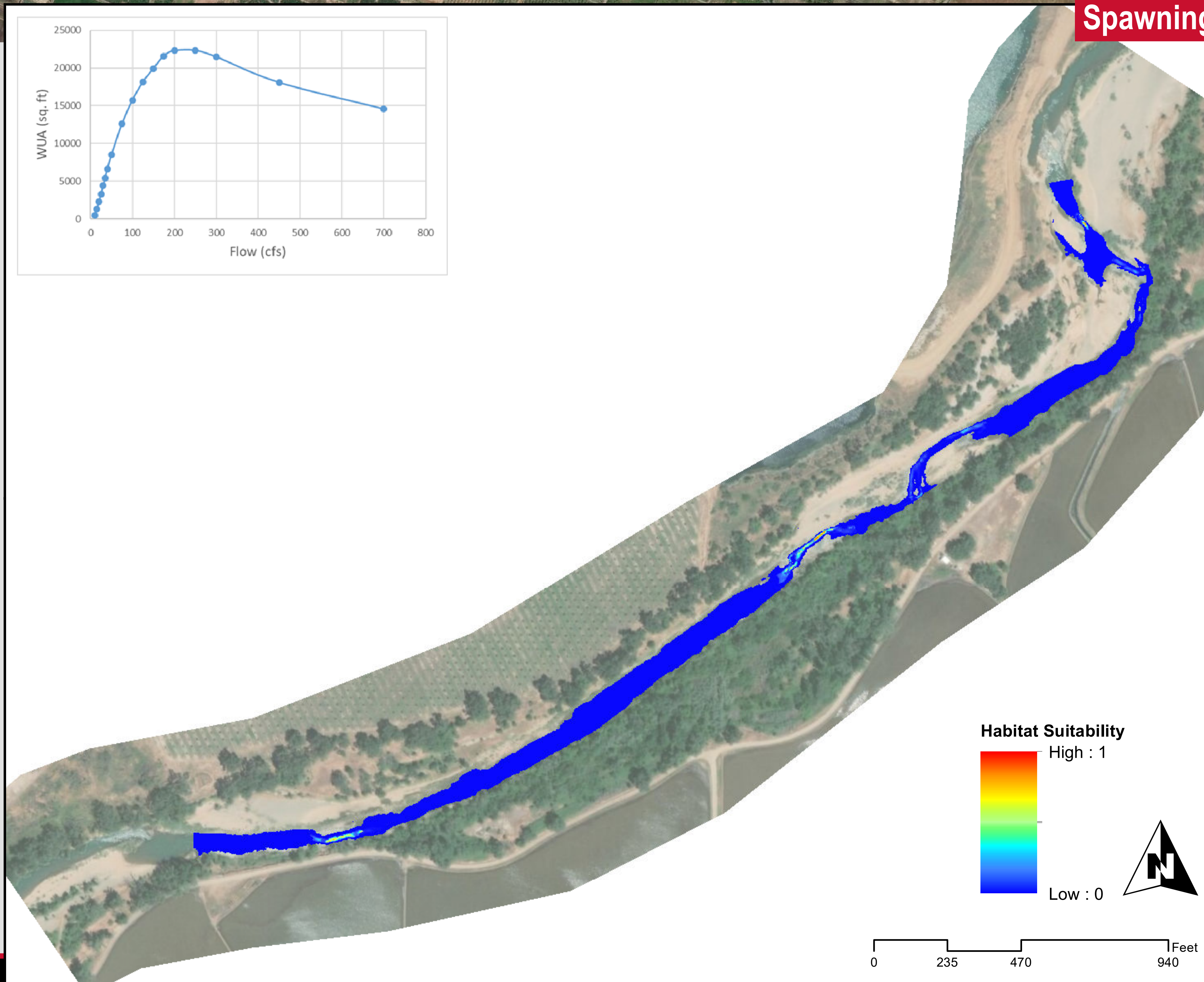
SSWD HDR

Steelhead

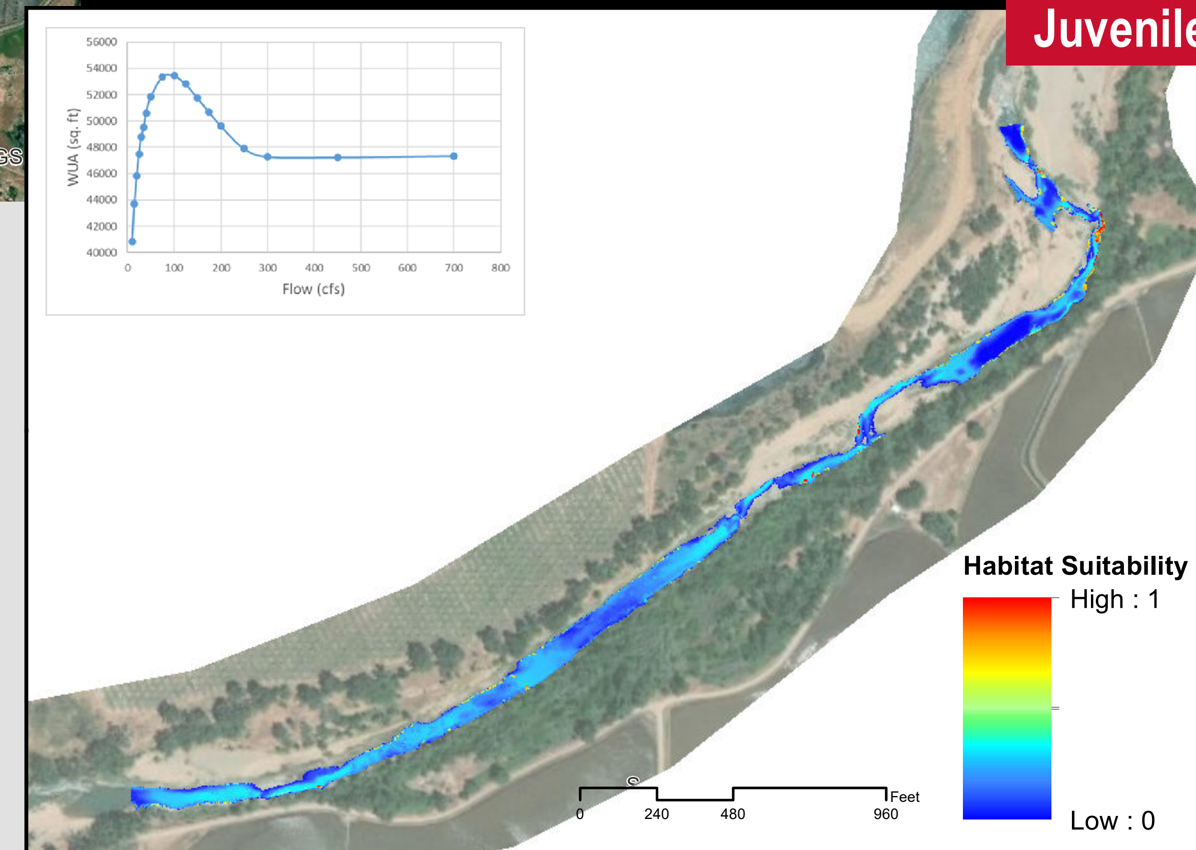
Upstream Study Site 20 cfs



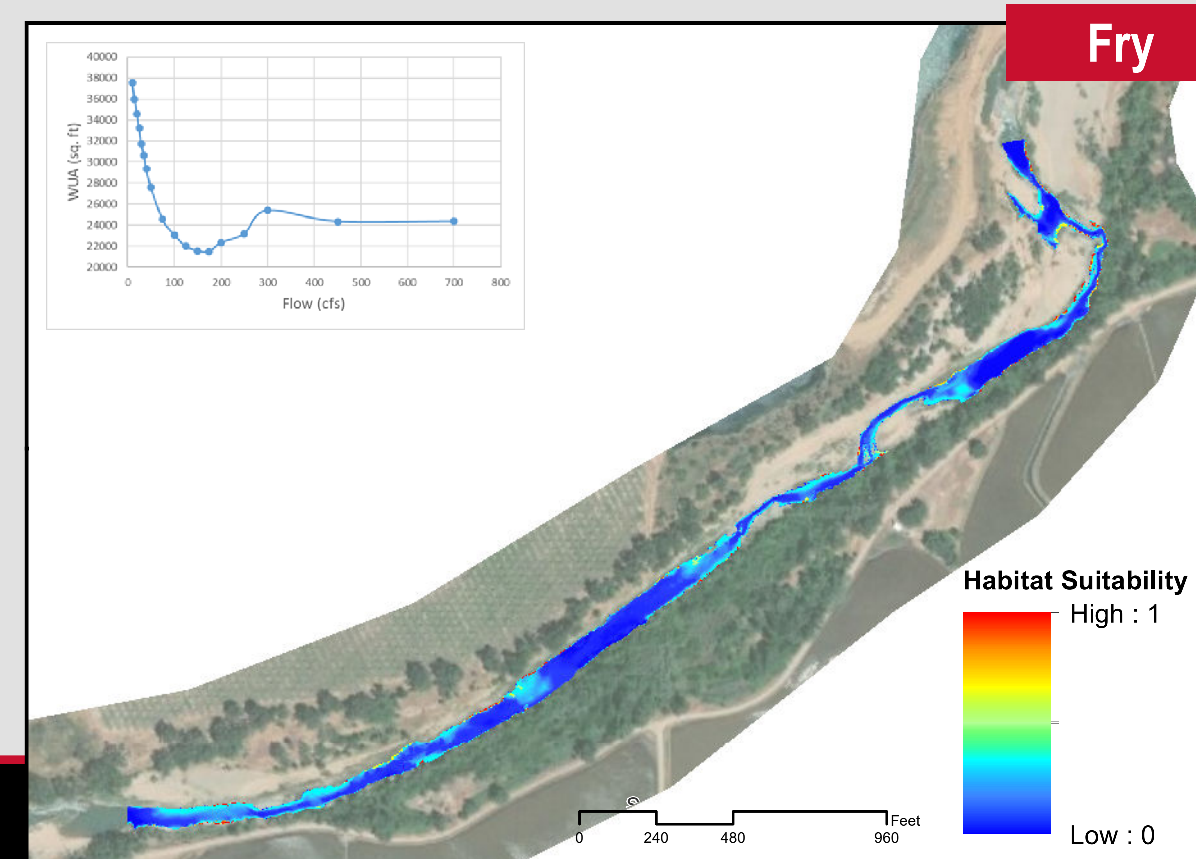
Spawning



Juvenile



Fry

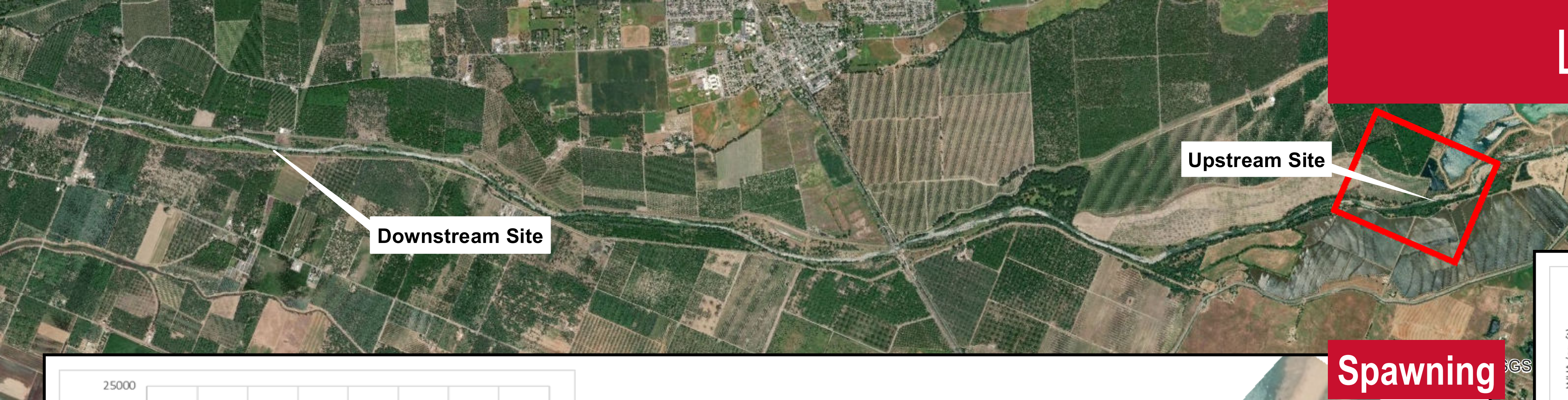


PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

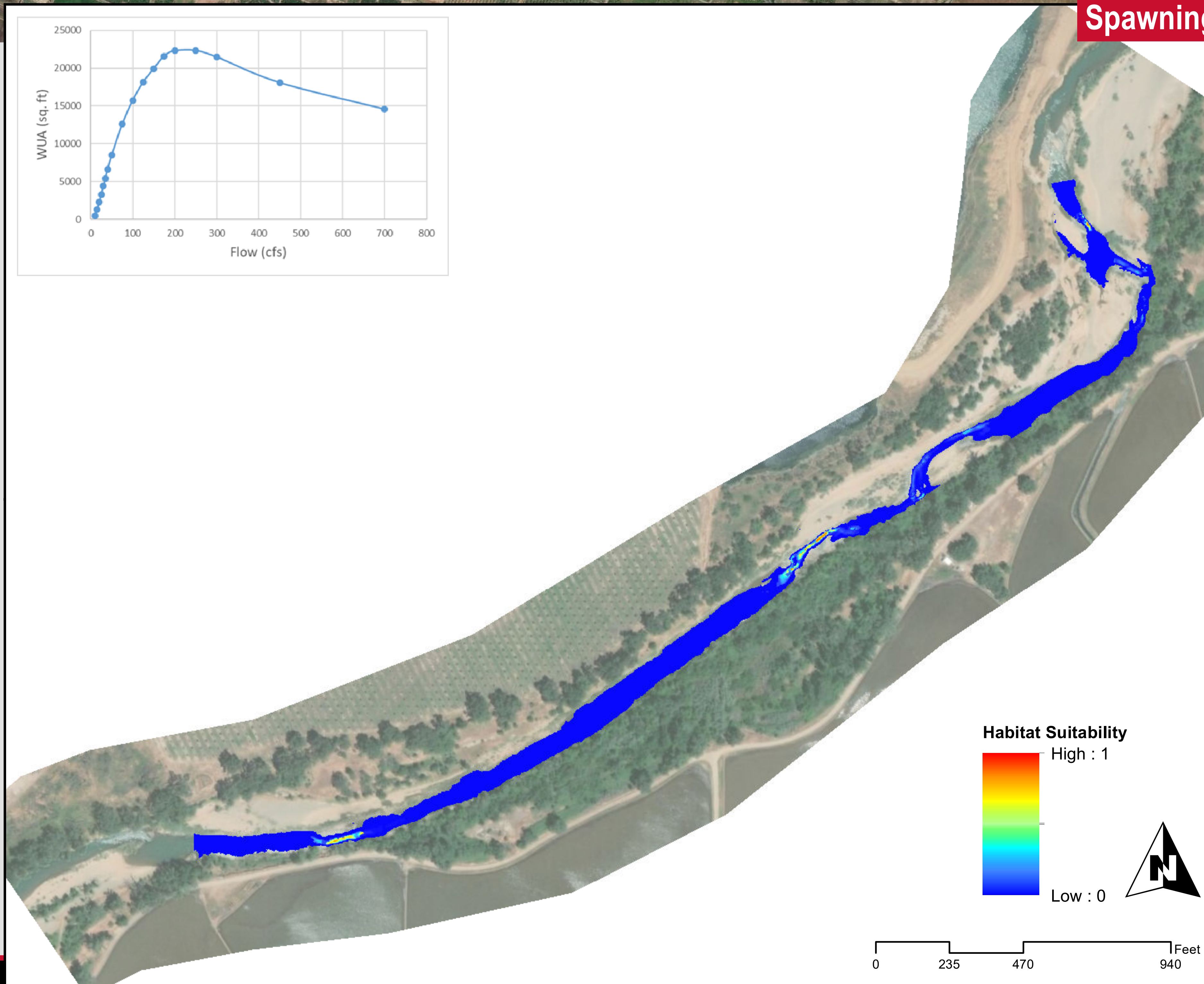
Lower Bear River - Instream Flow Study

Steelhead

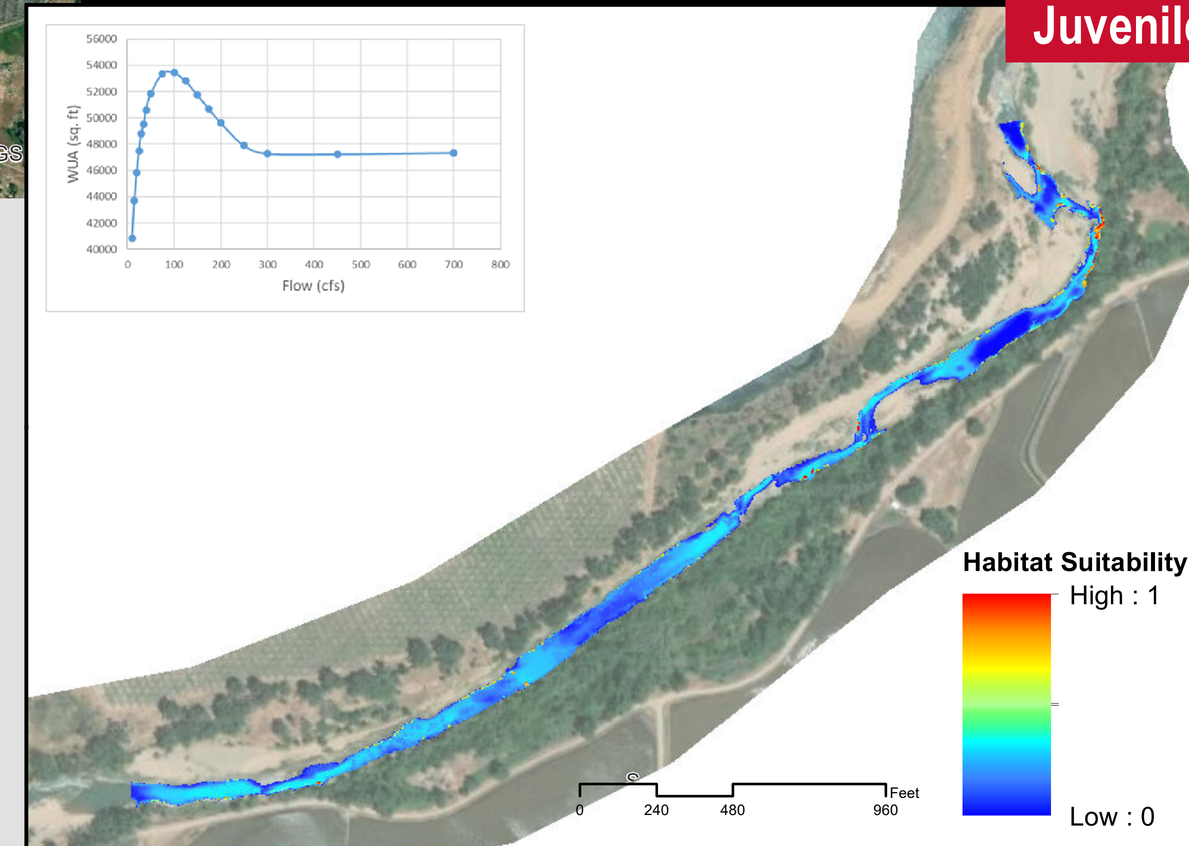
Upstream Study Site **25 cfs**



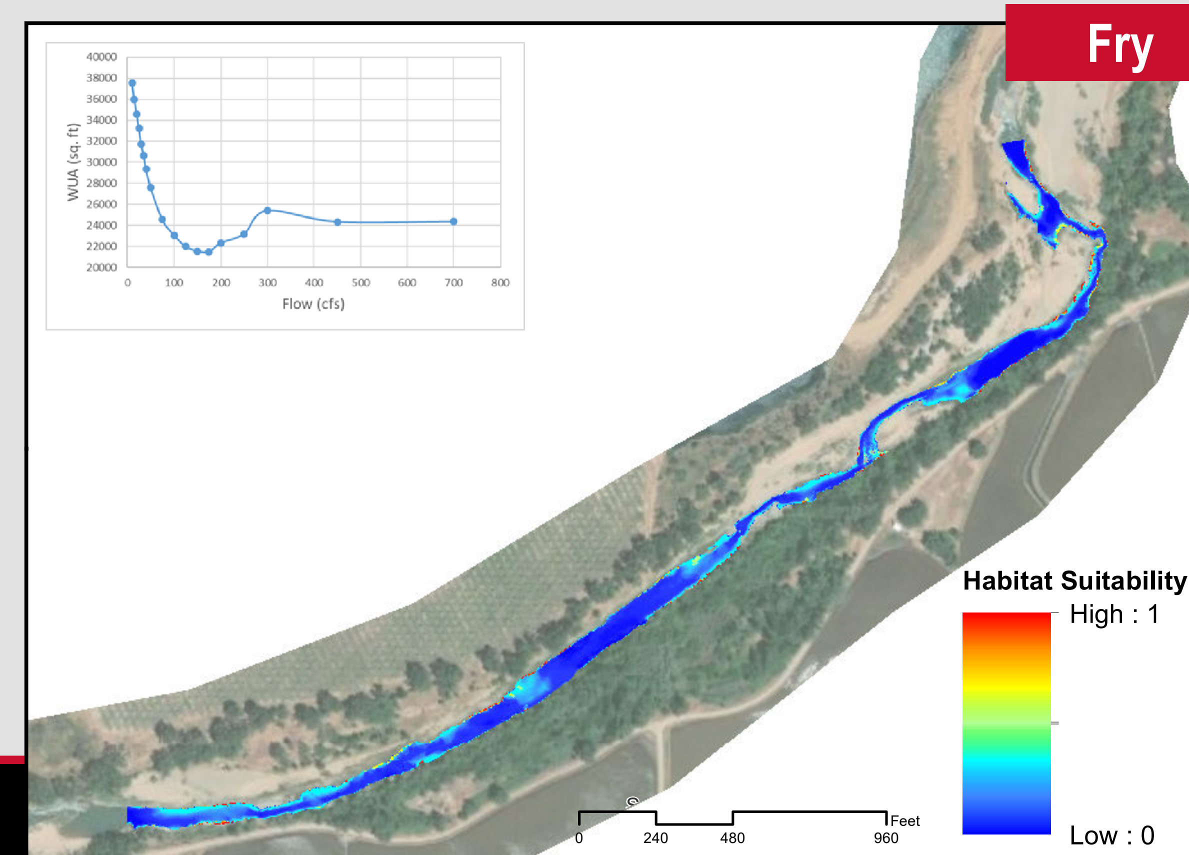
Spawning

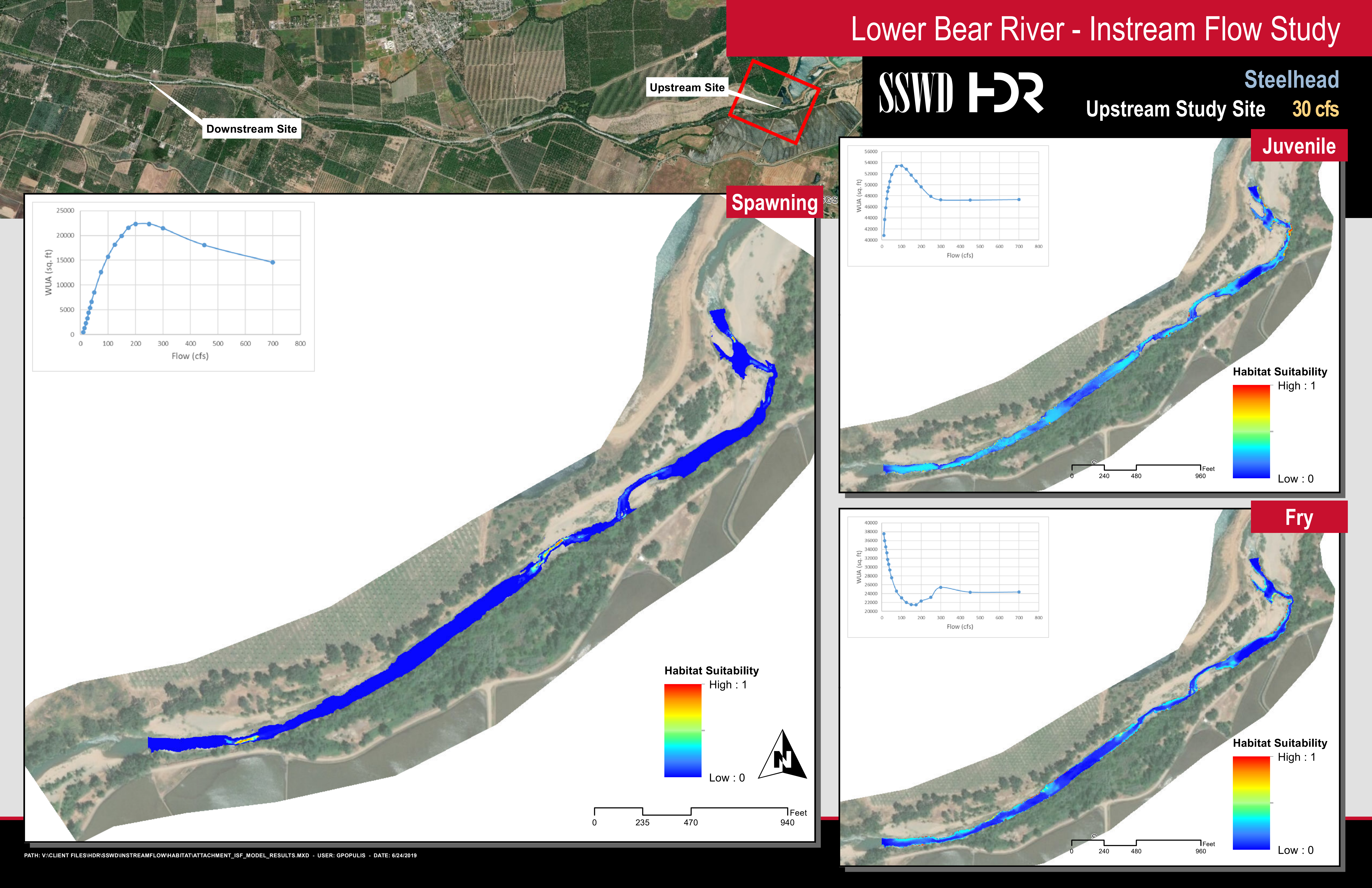


Juvenile



Fry





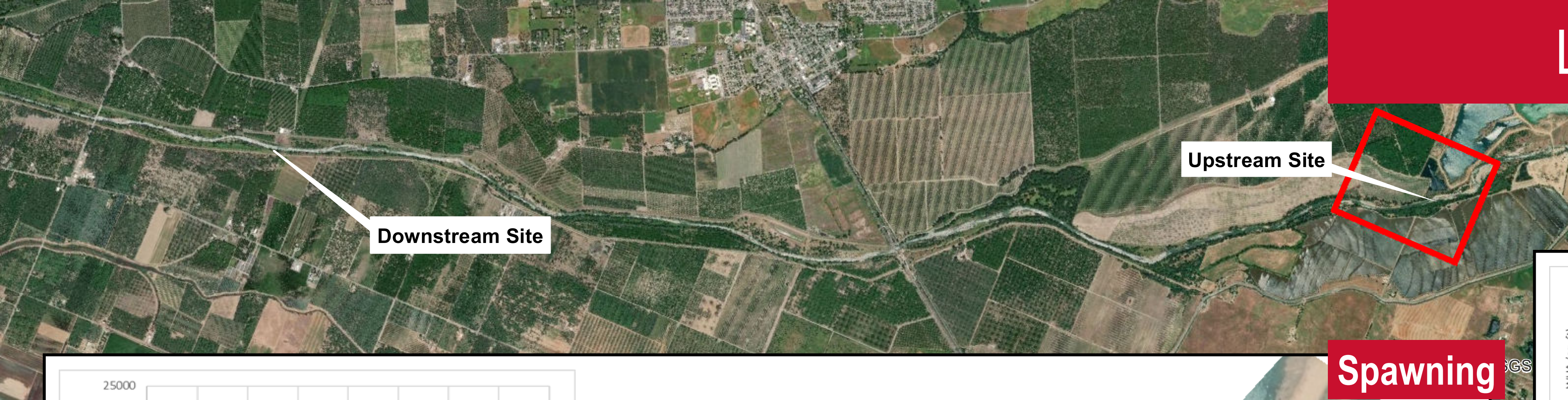
Lower Bear River - Instream Flow Study
SSWD
HDR
Steelhead
Upstream Study Site
30 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
235
470
940
N
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
240
480
960
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
Feet
0
240
480
960
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

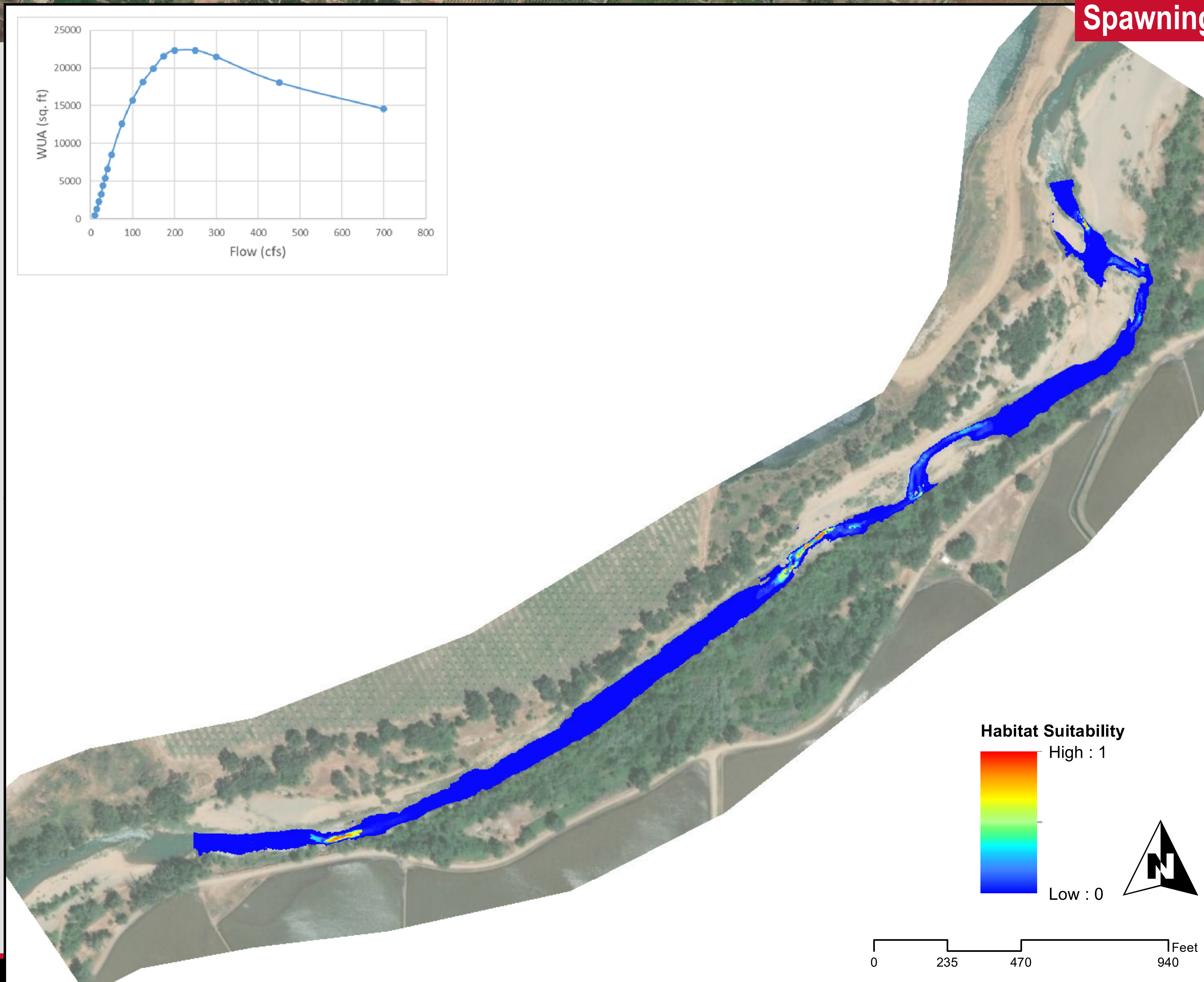
SSWD HDR

Steelhead

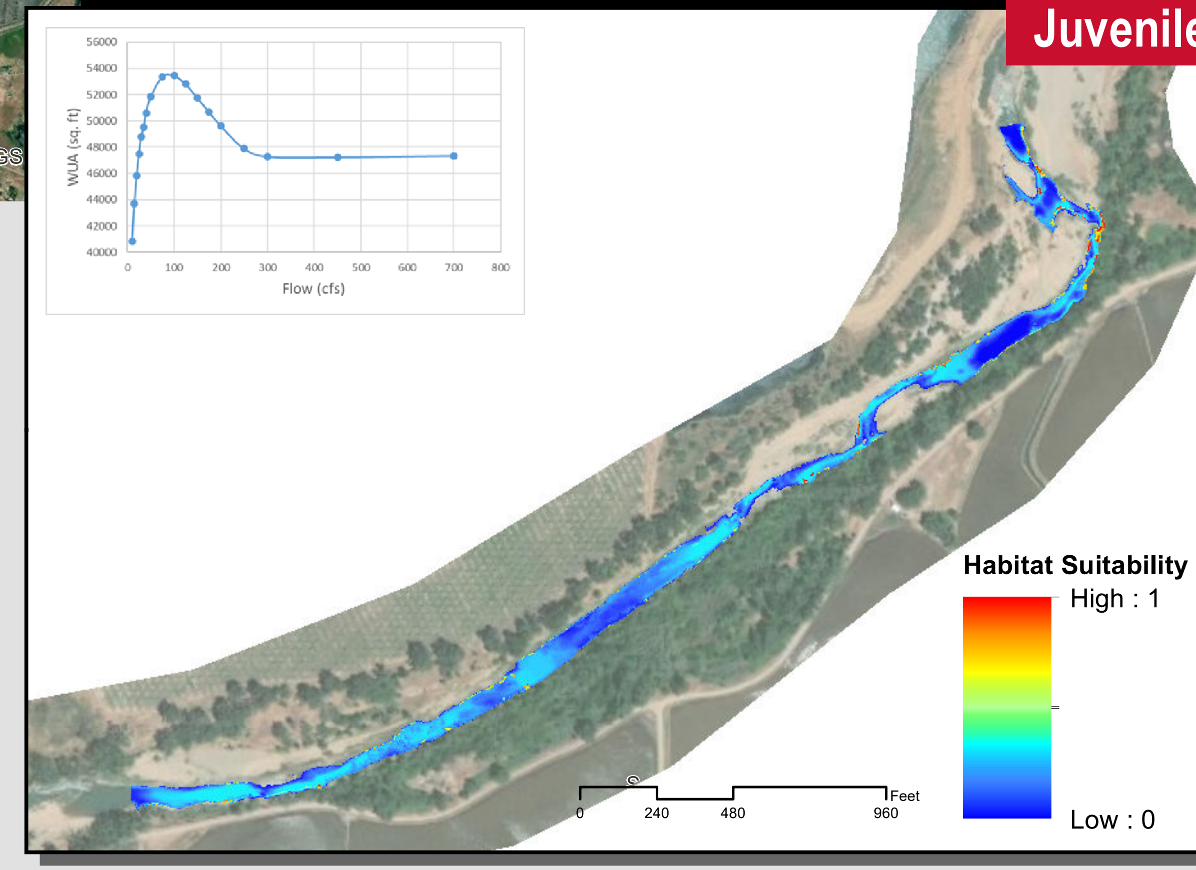
Upstream Study Site 35 cfs



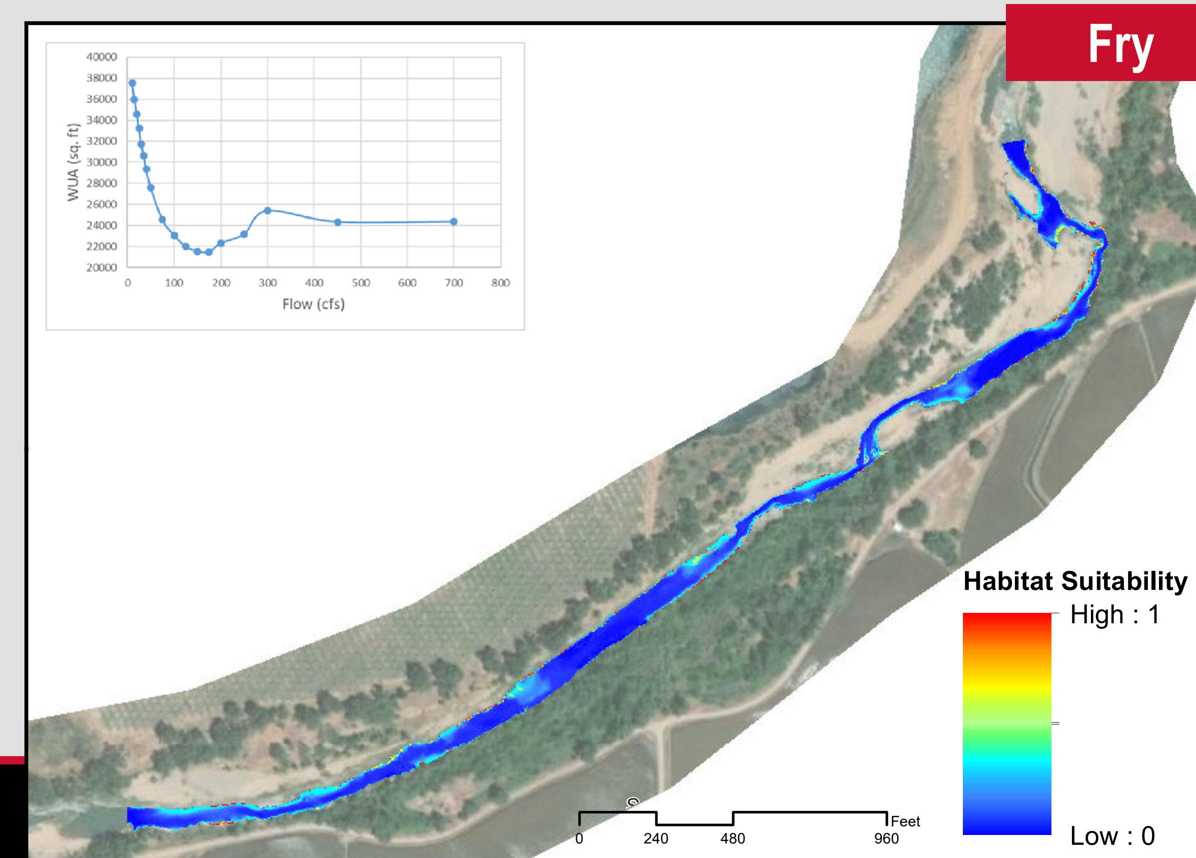
Spawning



Juvenile



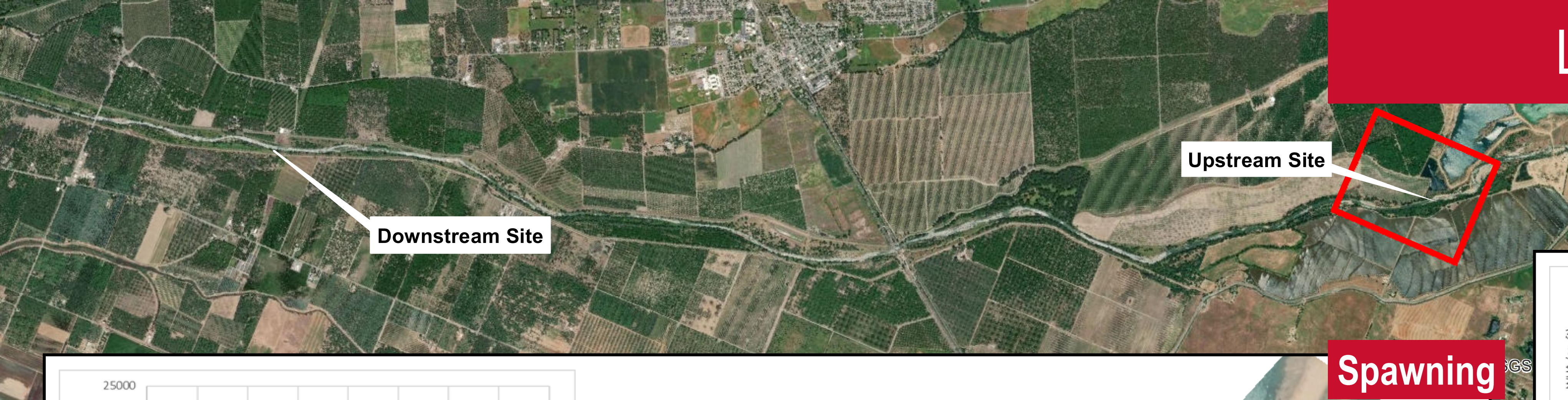
Fry

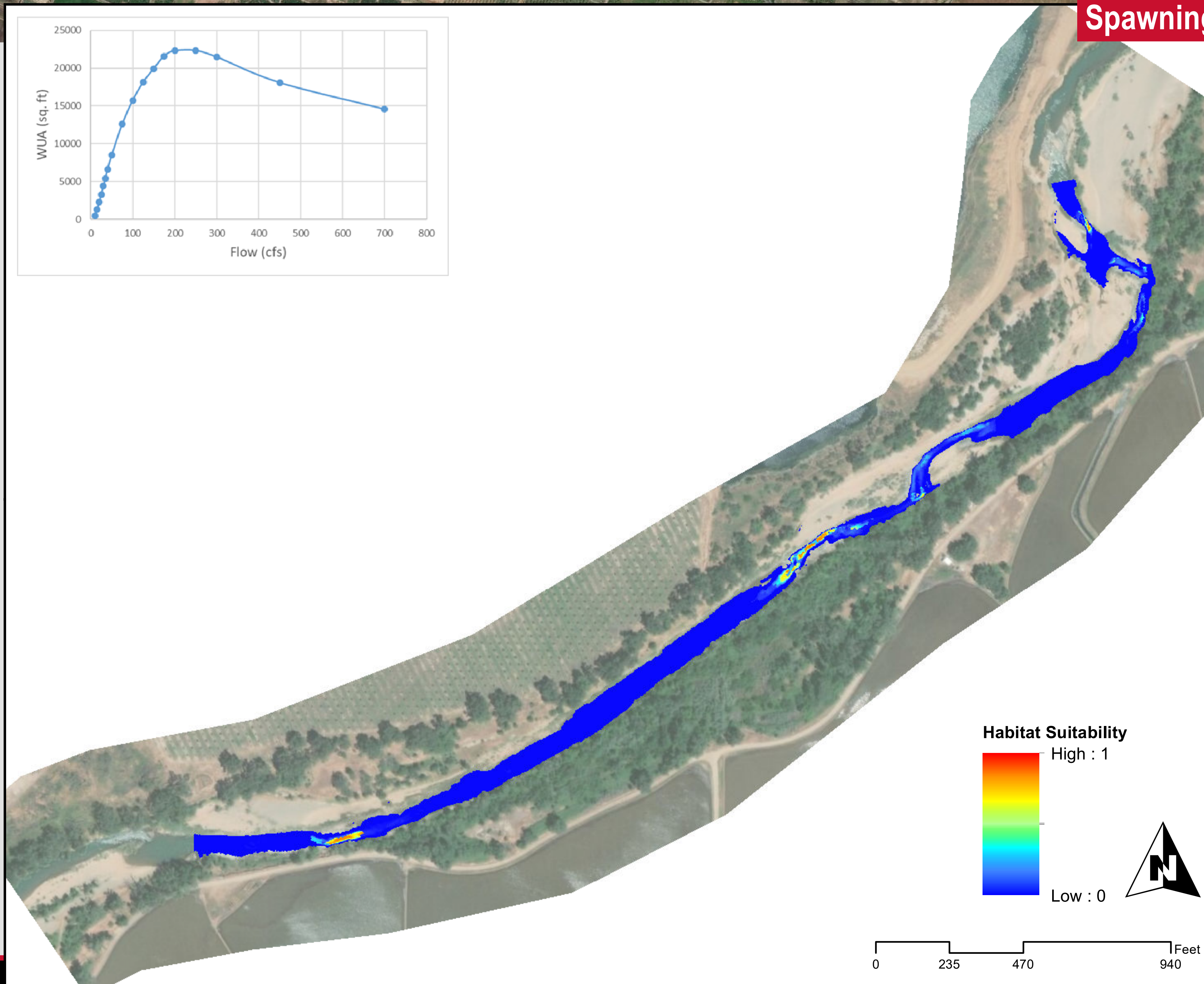


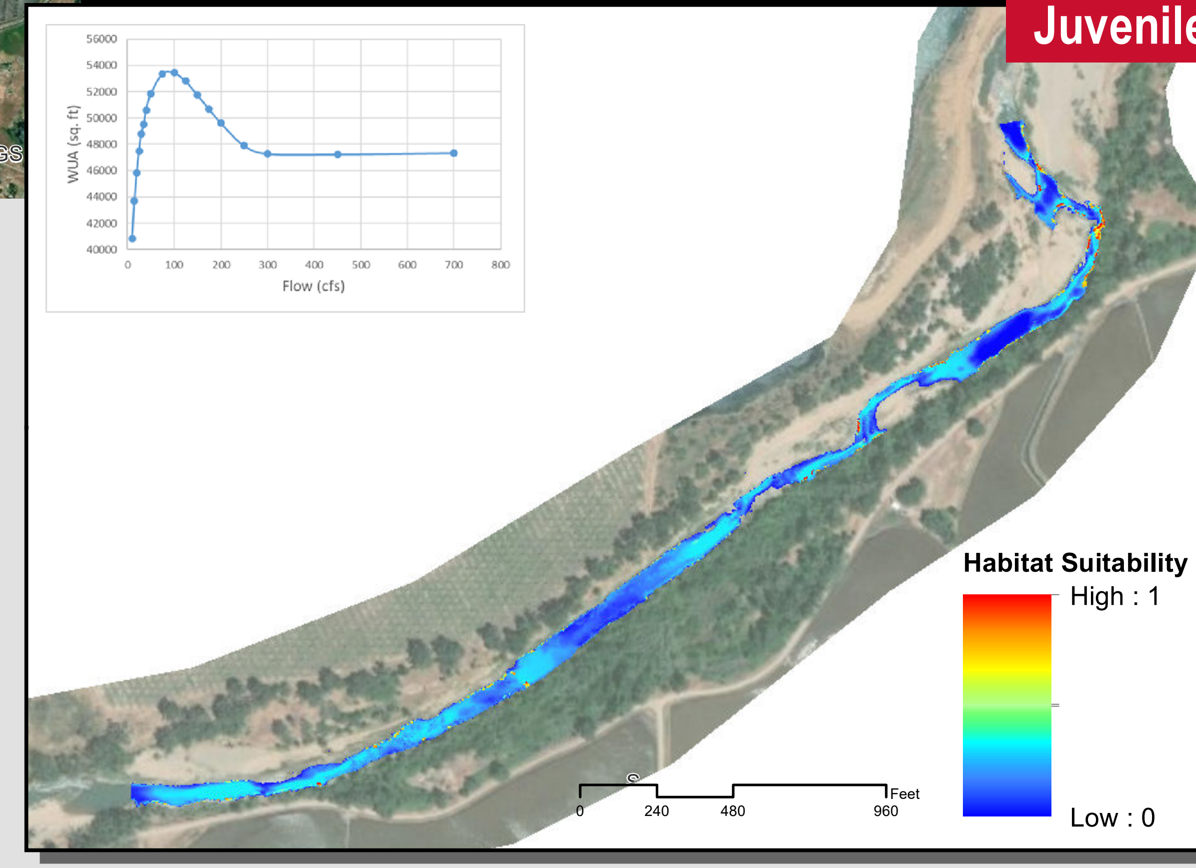
Lower Bear River - Instream Flow Study

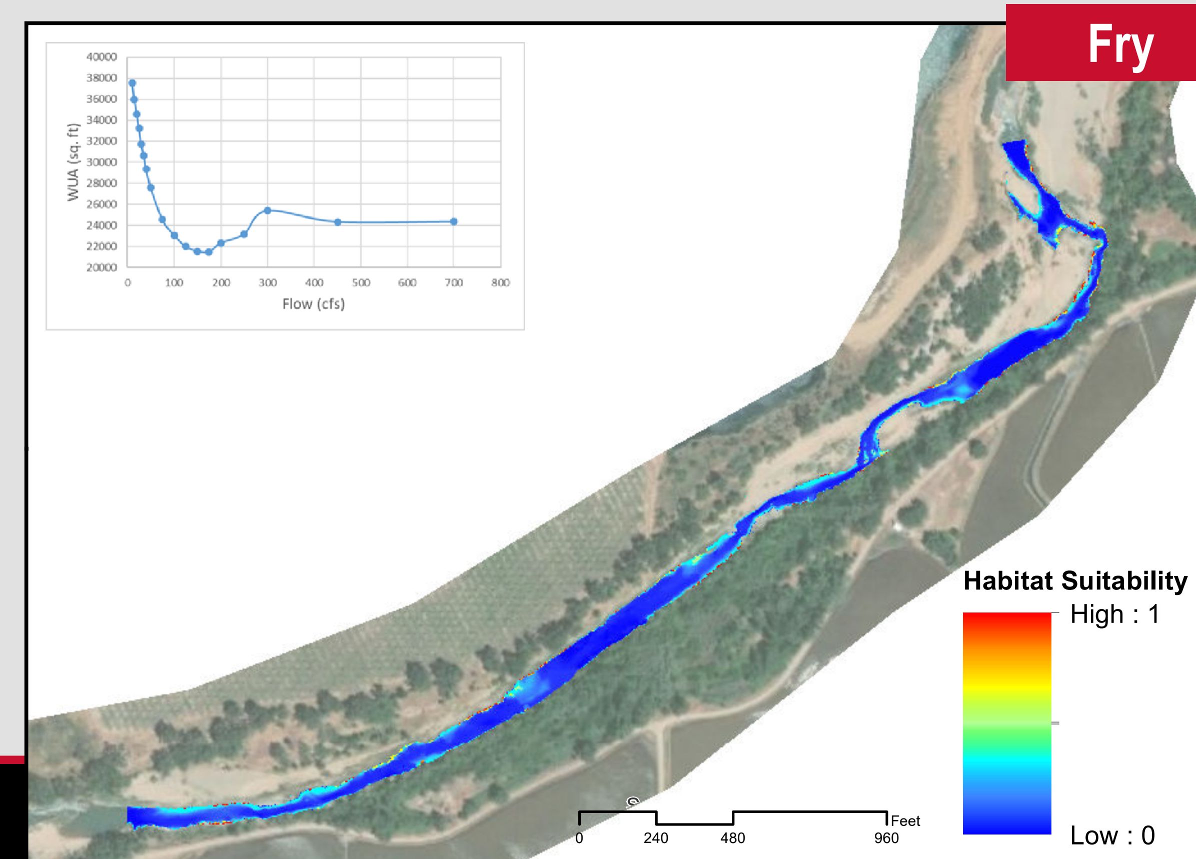
Steelhead

Upstream Study Site 40 cfs

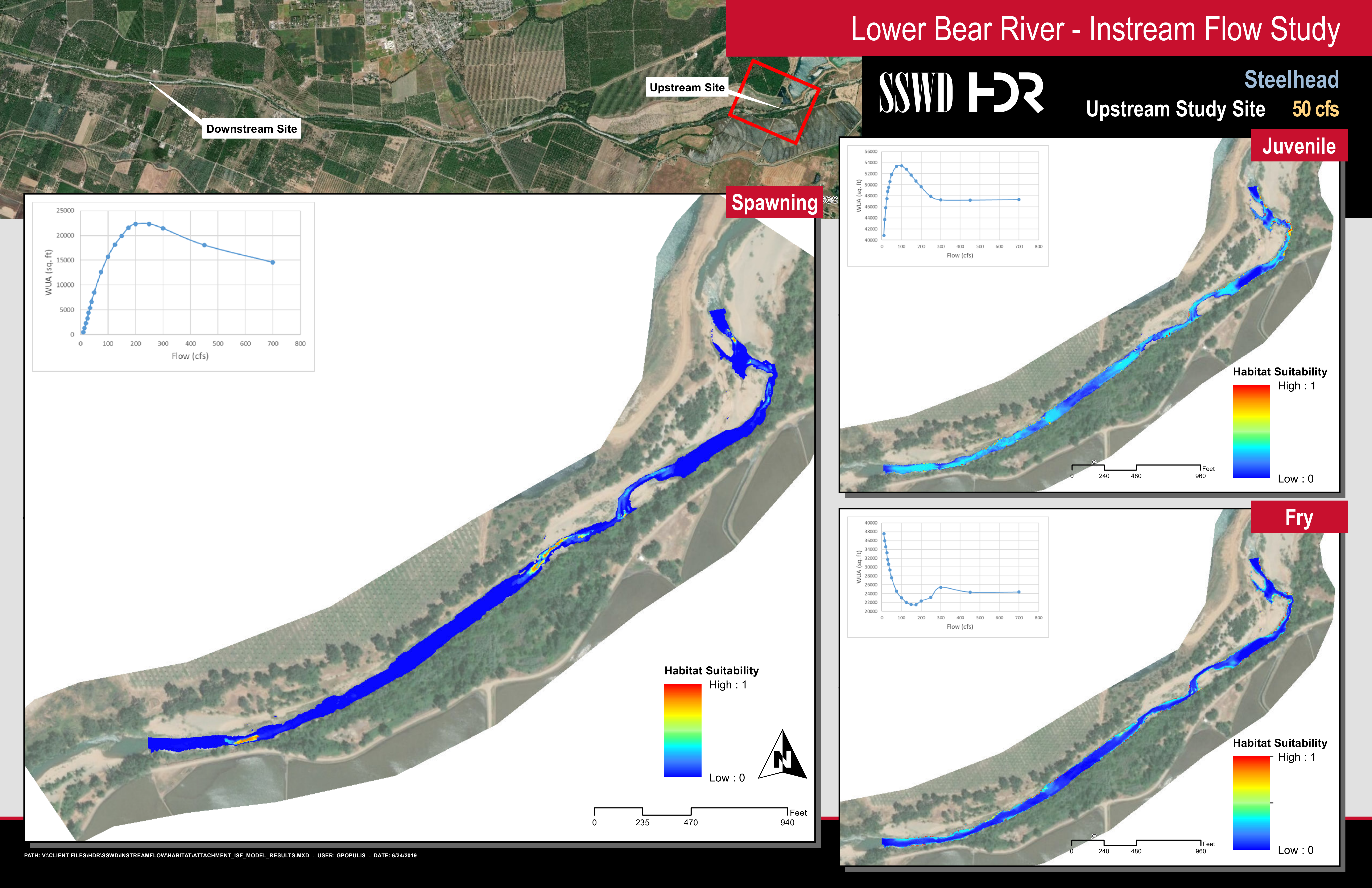








PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

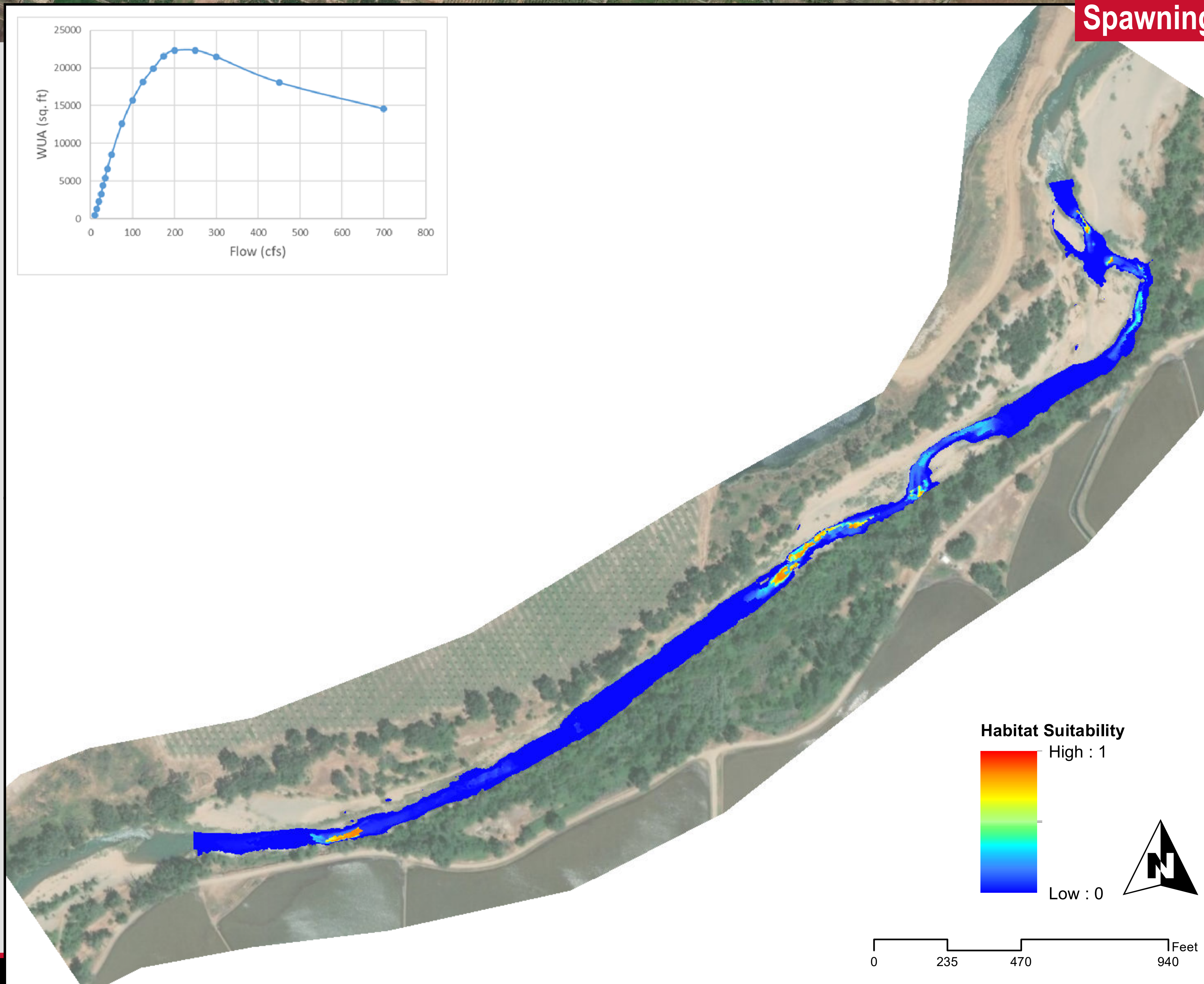

Lower Bear River - Instream Flow Study
SSWD
HDR
Steelhead
Upstream Study Site
50 cfs
Upstream Site
Downstream Site
Spawning
25000
20000
15000
10000
5000
0
WUA (sq. ft)
0
100
200
300
400
500
600
700
800
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
N
0
235
470
940
Feet
Juvenile
56000
54000
52000
50000
48000
46000
44000
42000
40000
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
Fry
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

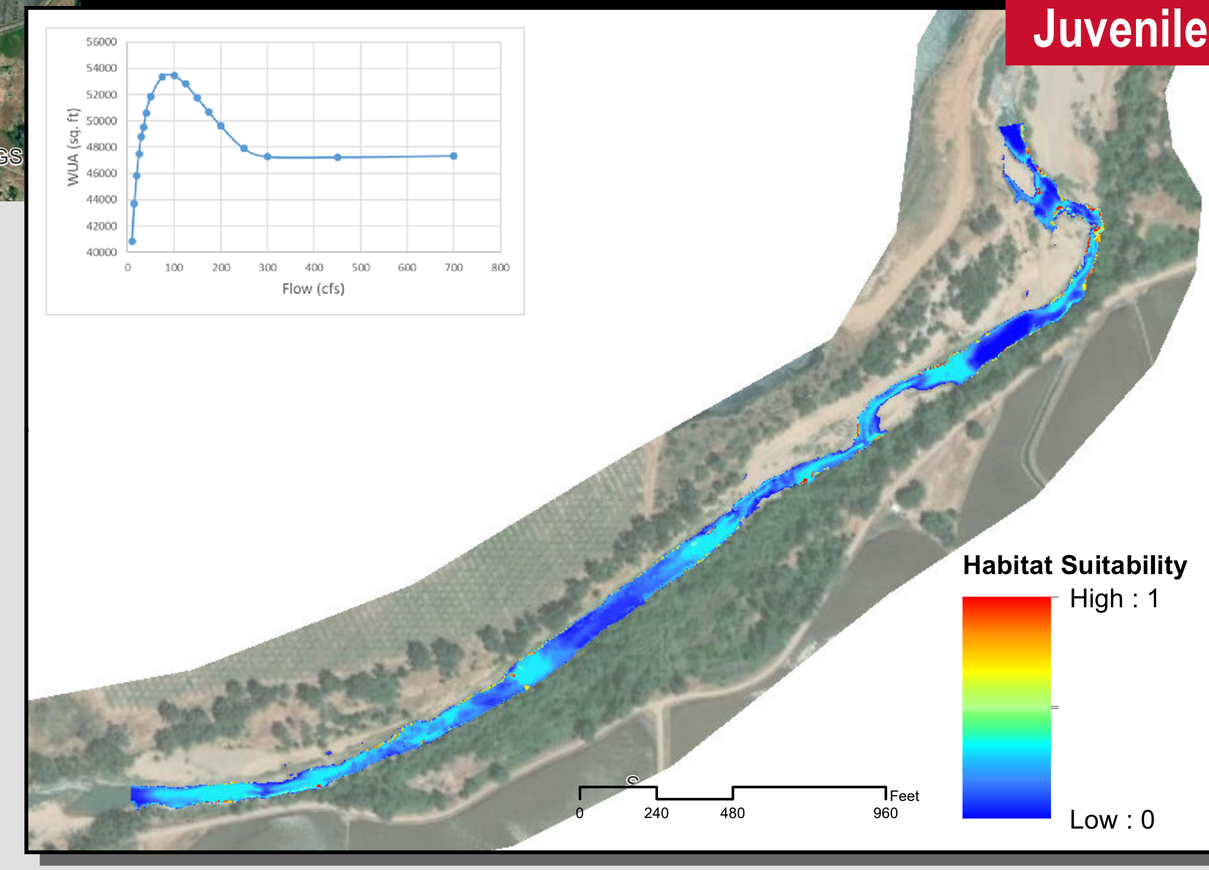
Lower Bear River - Instream Flow Study

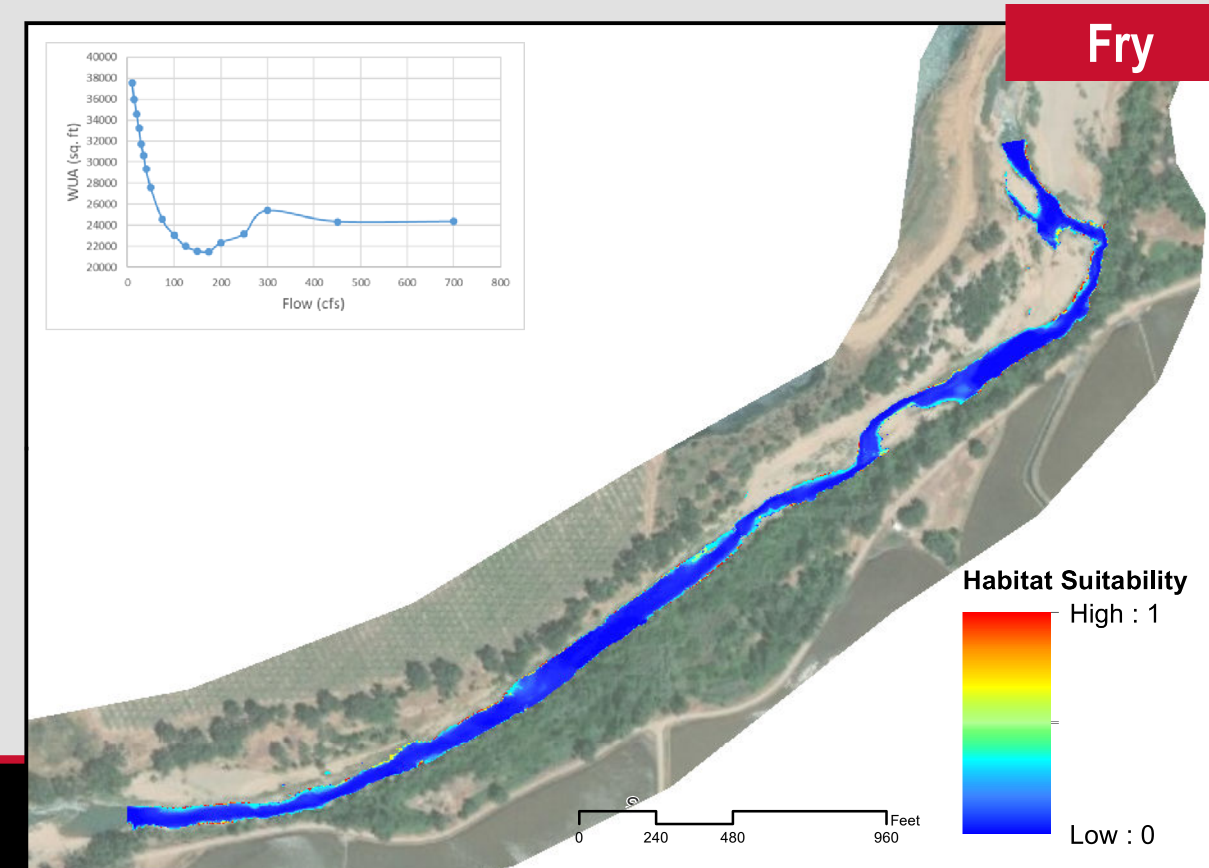
SSWD HDR

Steelhead

Upstream Study Site 75 cfs







PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

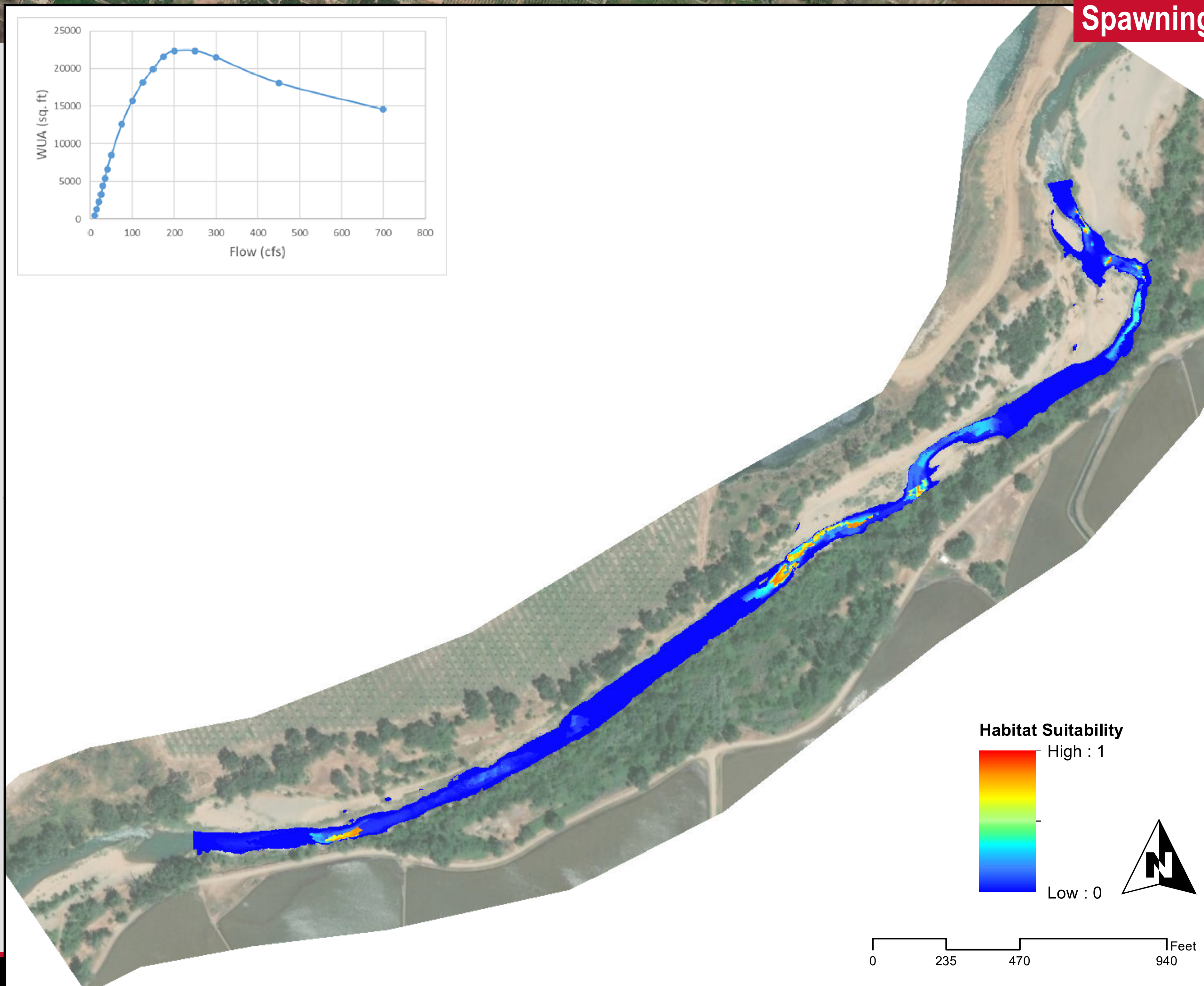
Lower Bear River - Instream Flow Study

SSWD HDR

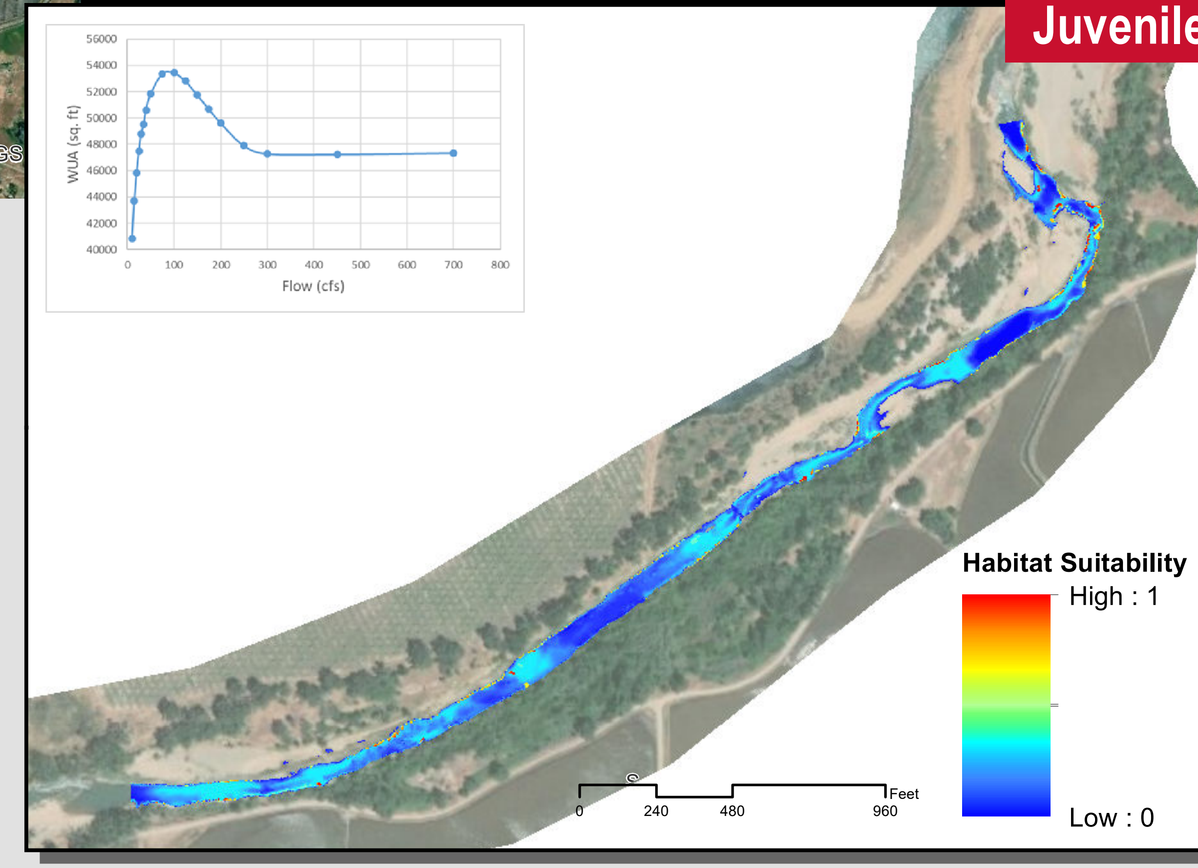
Steelhead

Upstream Study Site 100 cfs

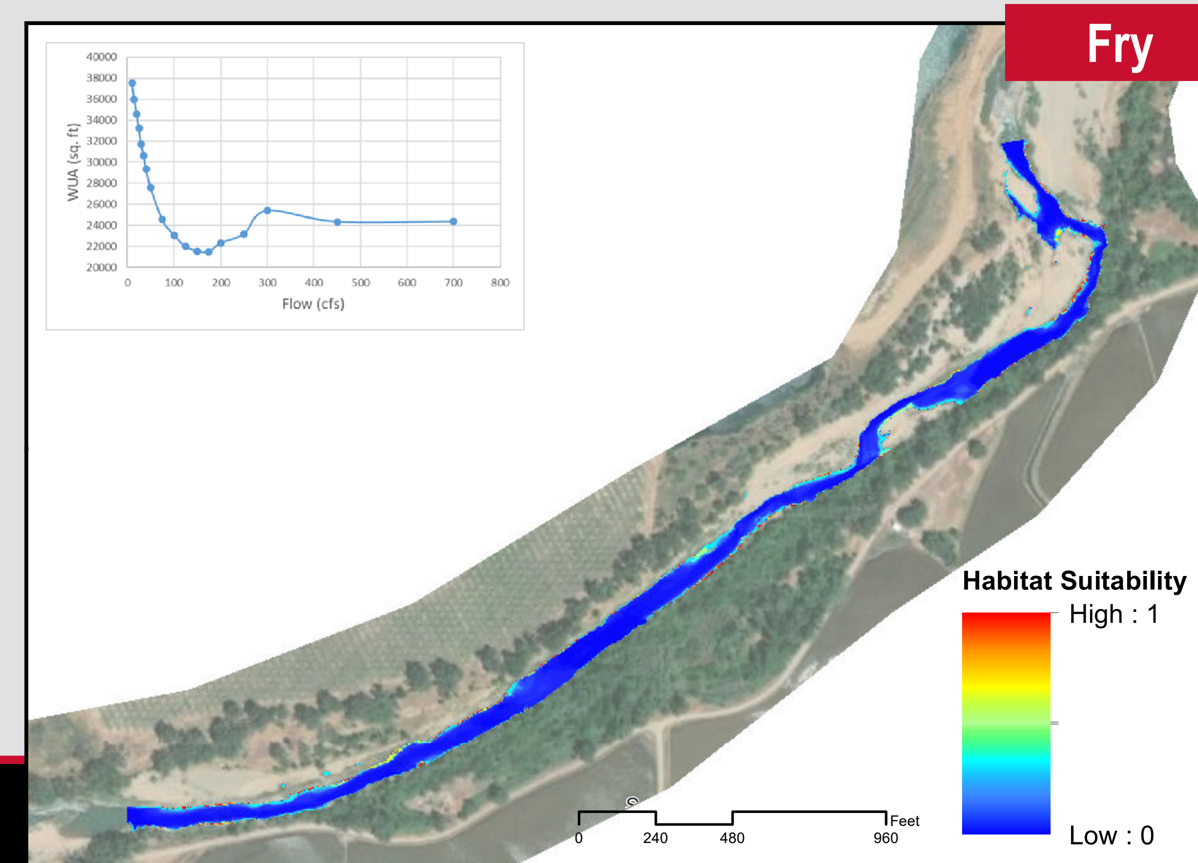
Spawning



Juvenile



Fry



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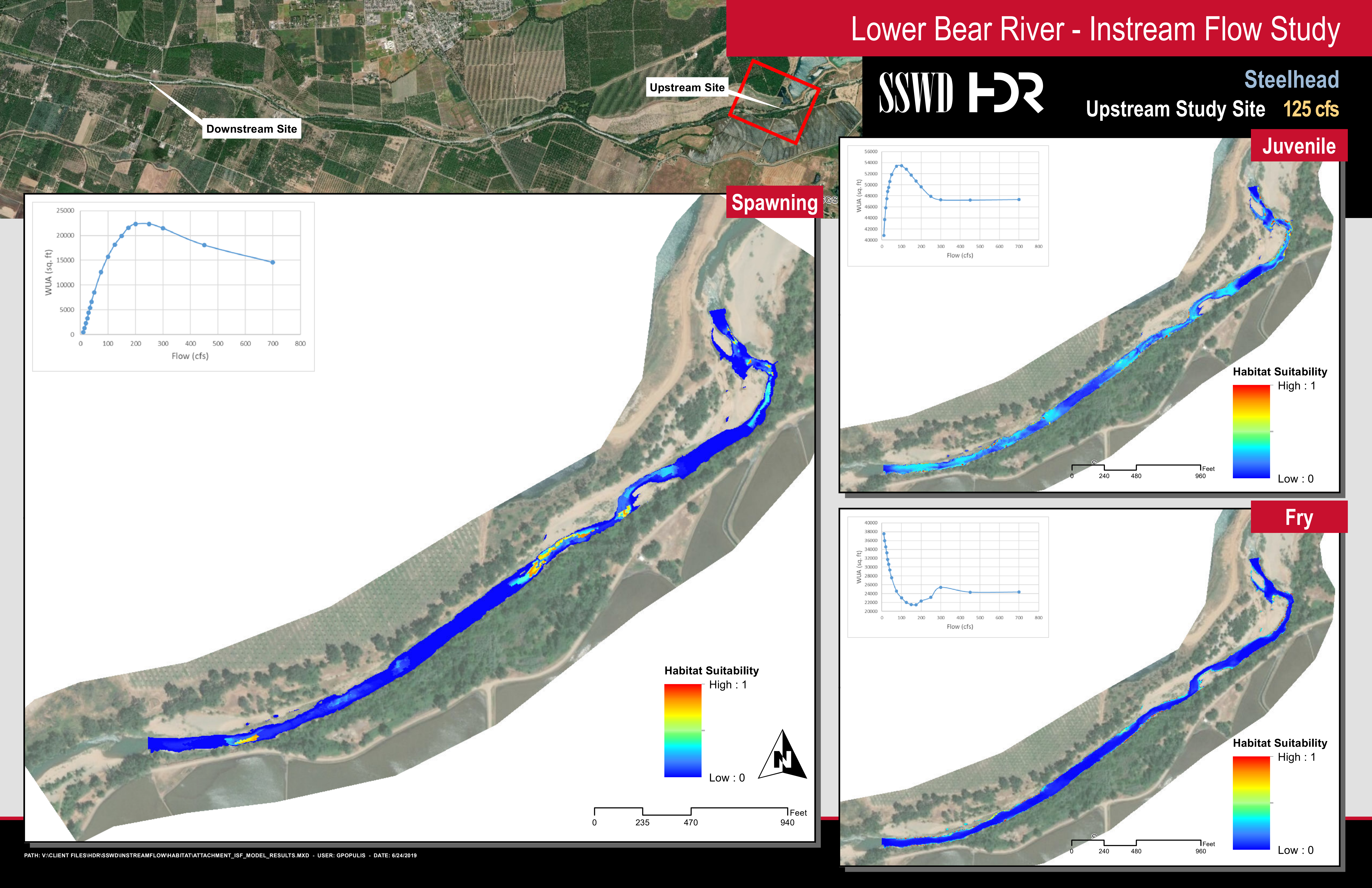


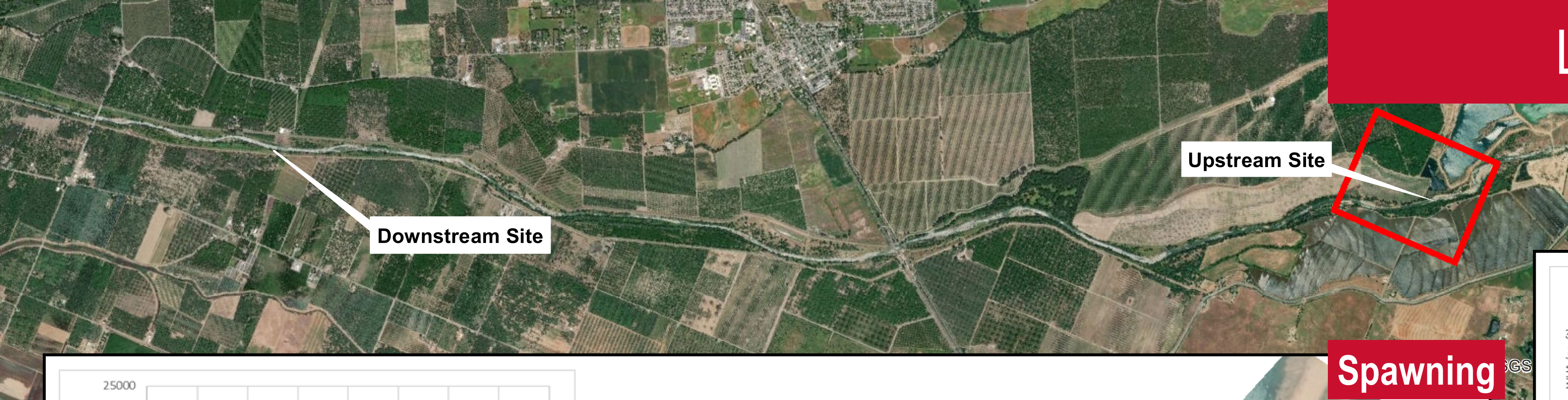
Lower Bear River - Instream Flow Study
SSWD
HDR
Steelhead
Upstream Study Site
125 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
N
0
235
470
940
Feet
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0
240
480
960
Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

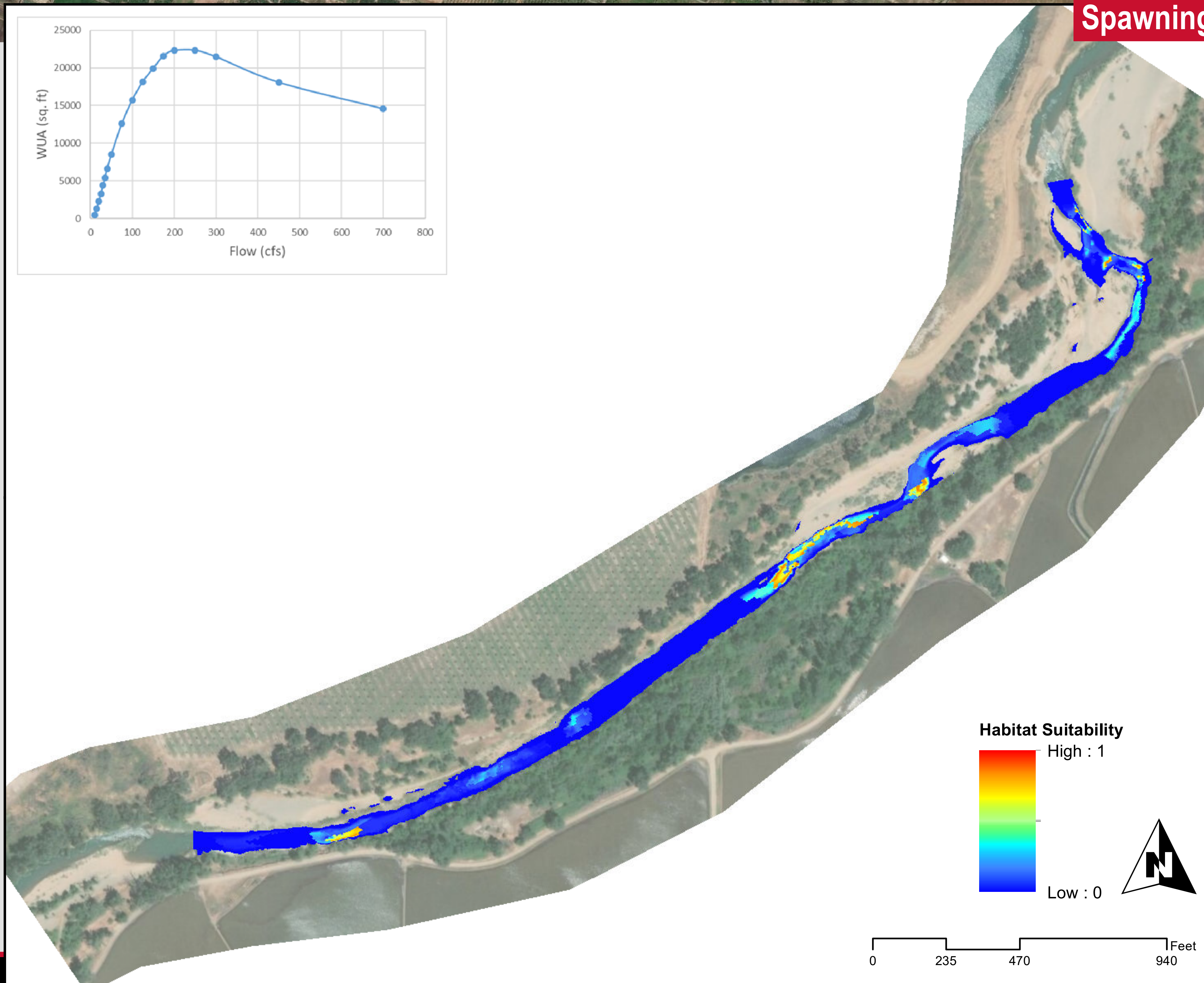
Lower Bear River - Instream Flow Study

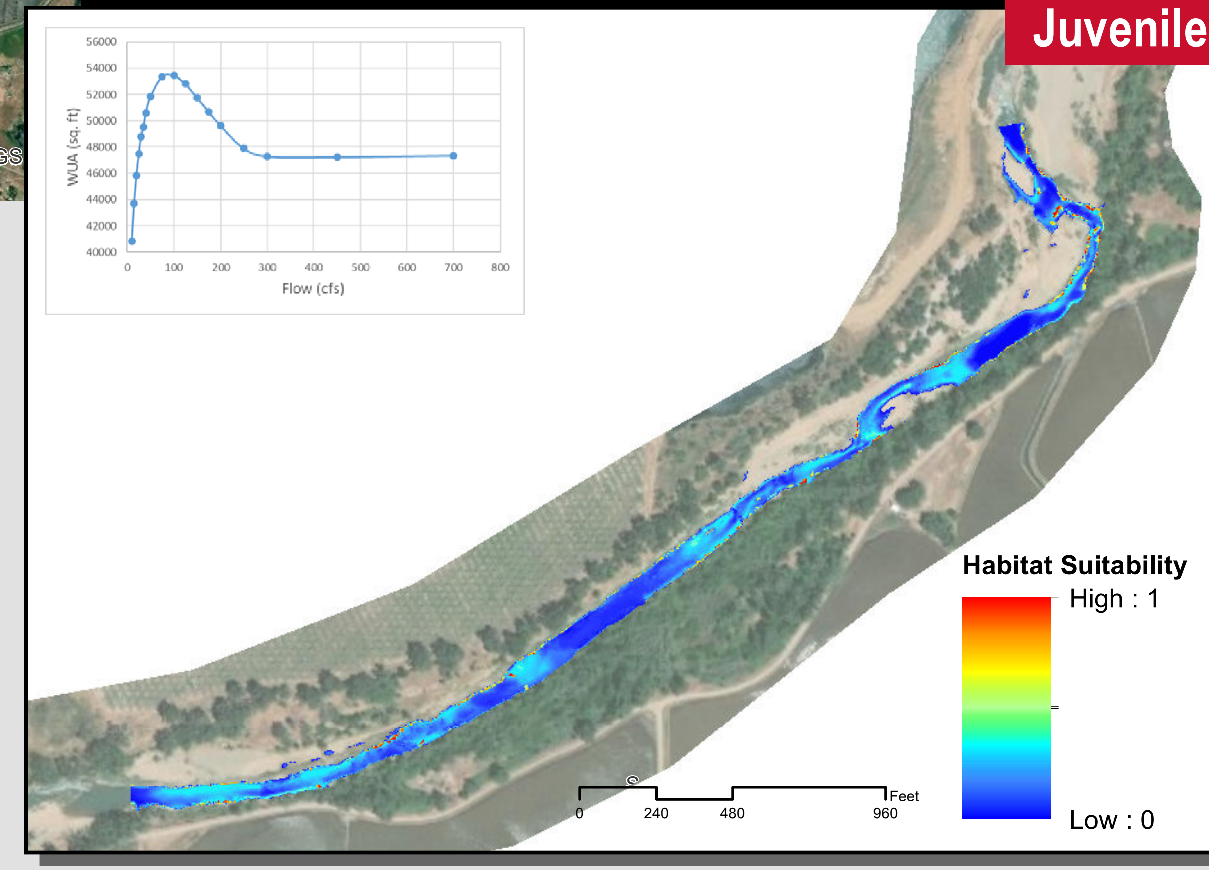
SSWD HDR

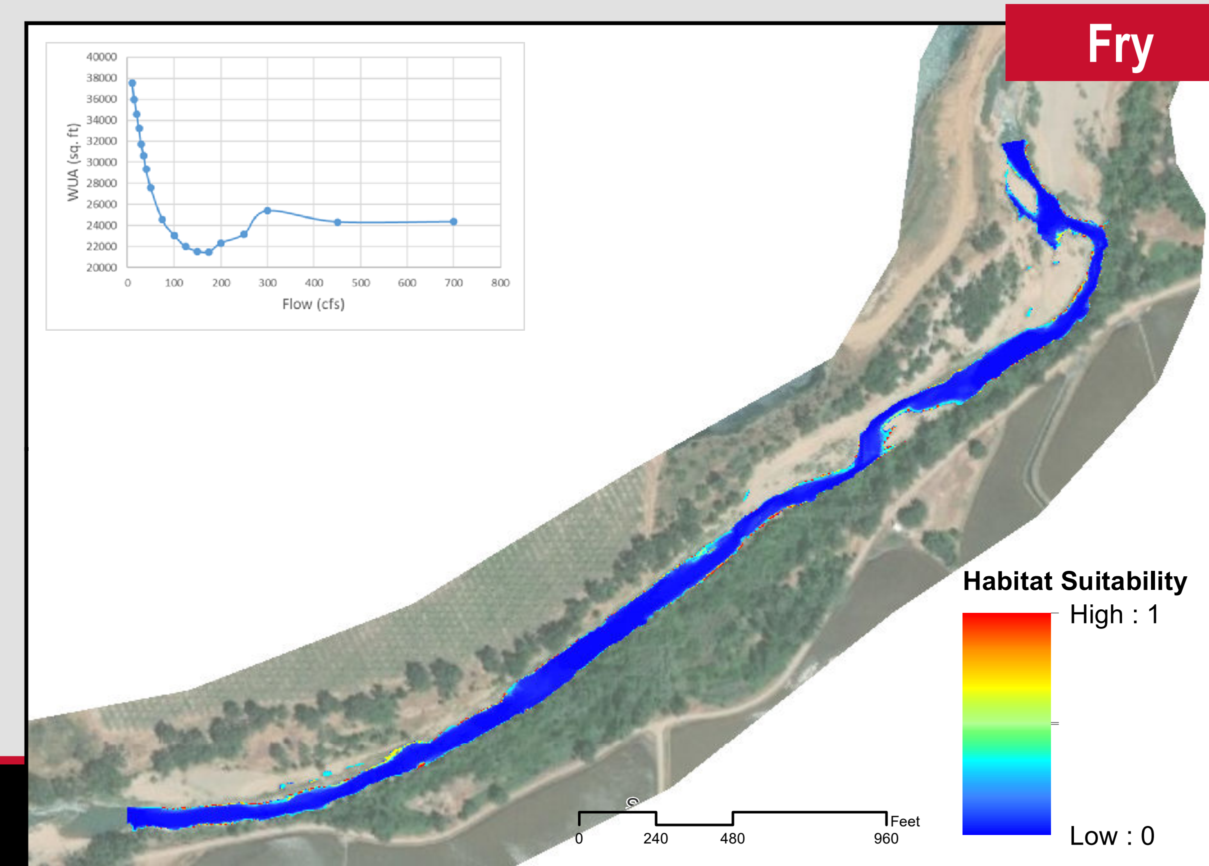
Steelhead

Upstream Study Site 150 cfs









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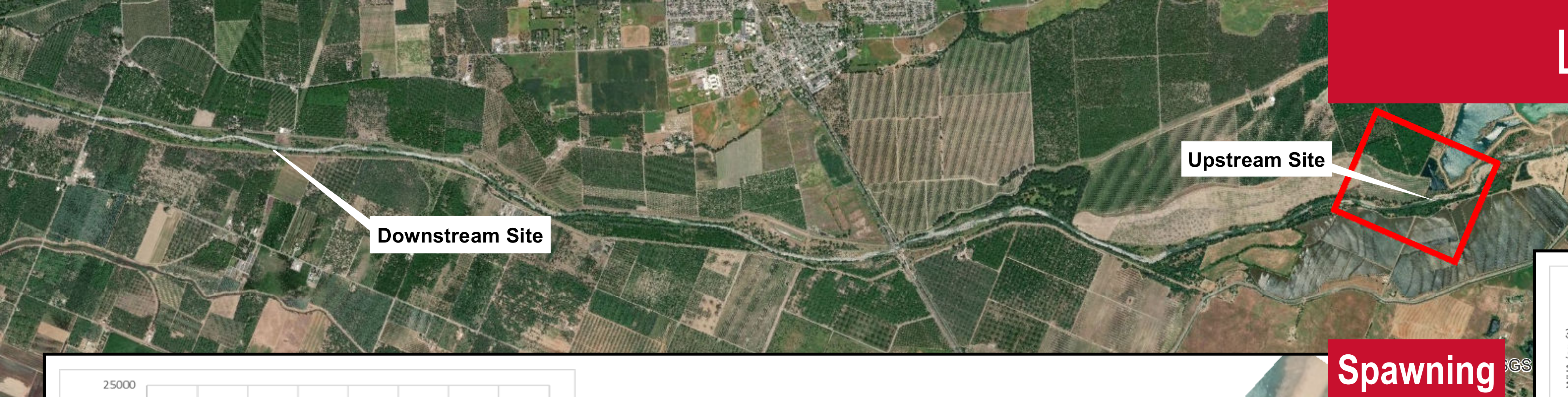
Lower Bear River - Instream Flow Study

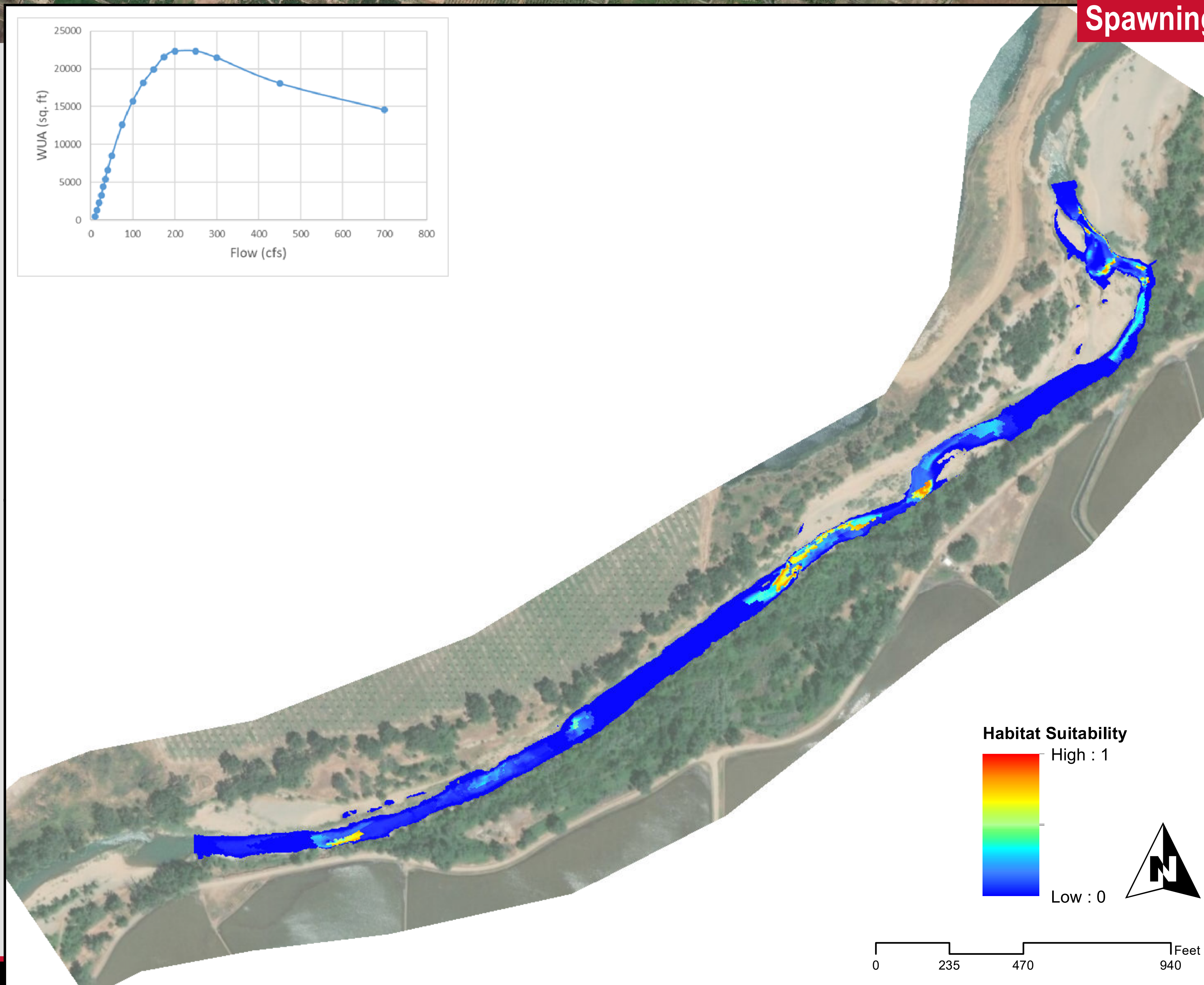
SSWD HDR

Steelhead

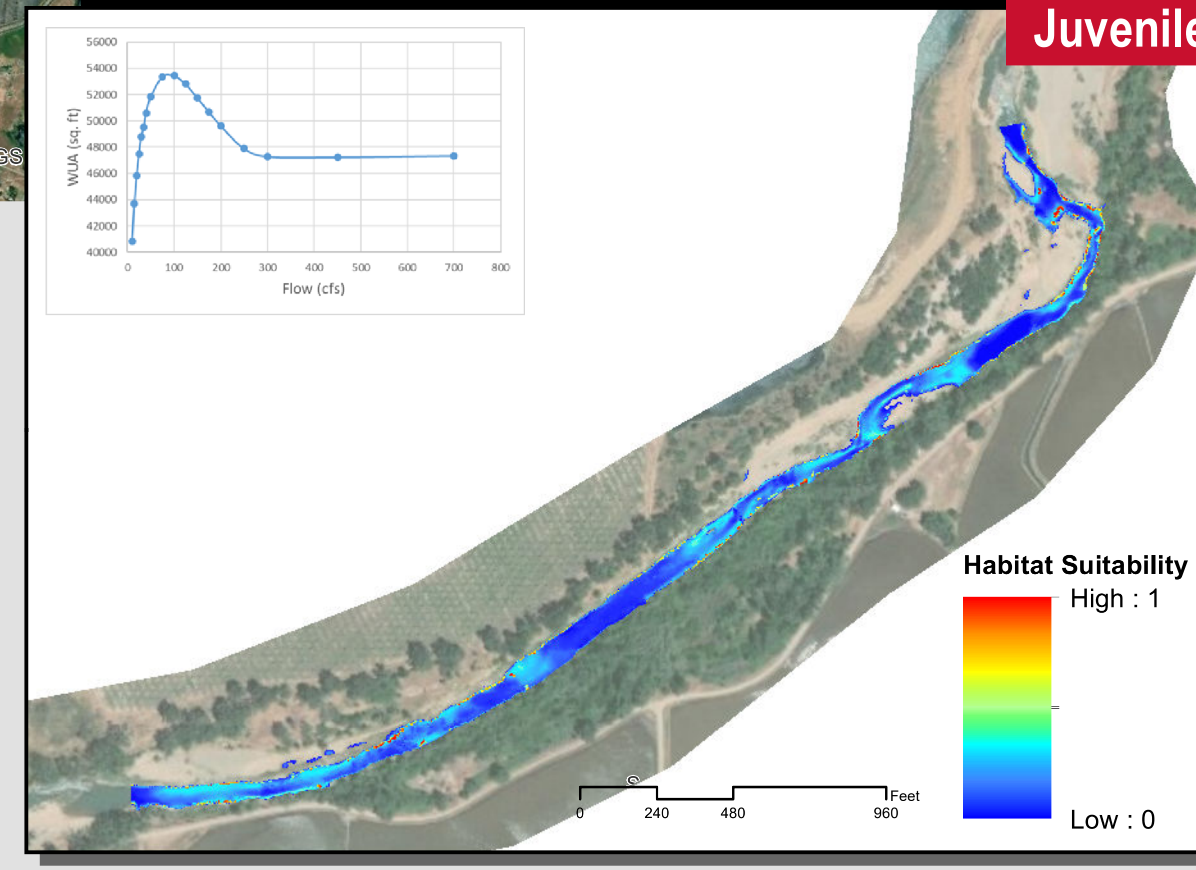
Upstream Study Site 175 cfs



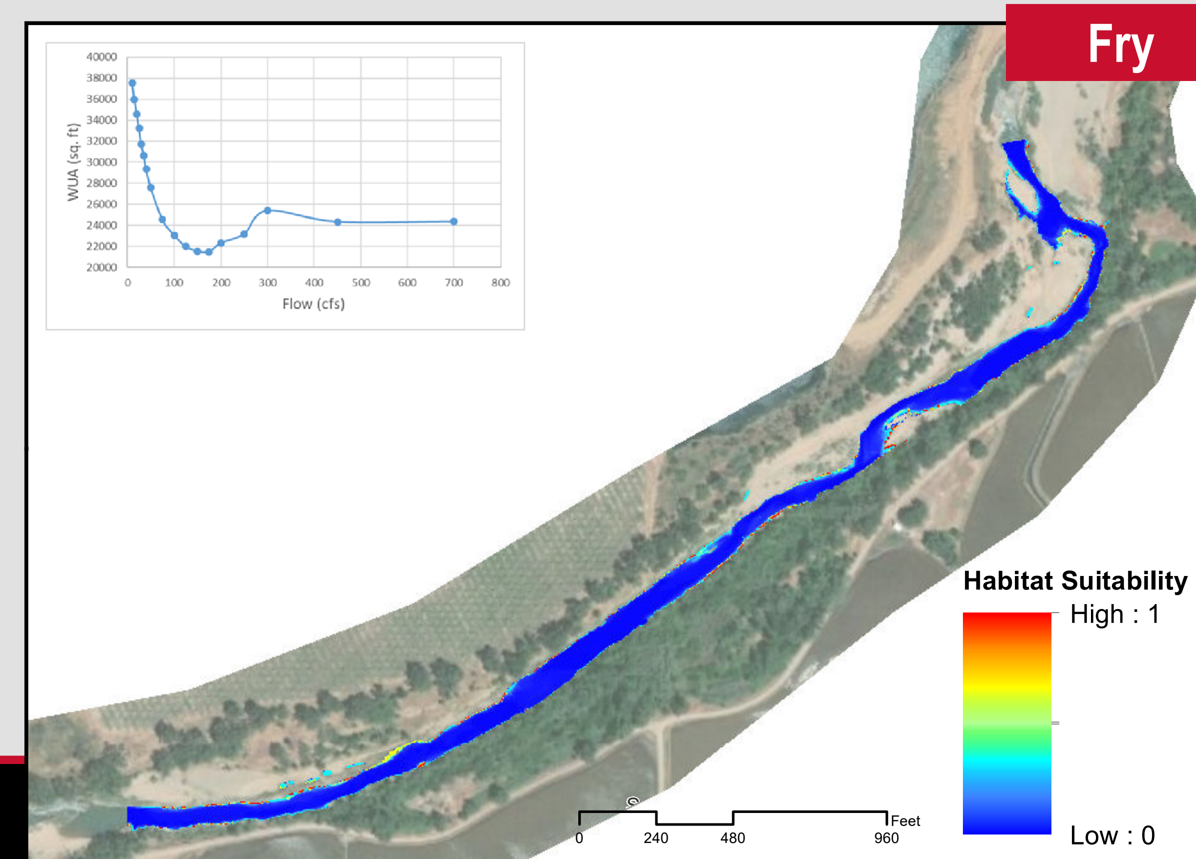
Spawning



Juvenile



Fry

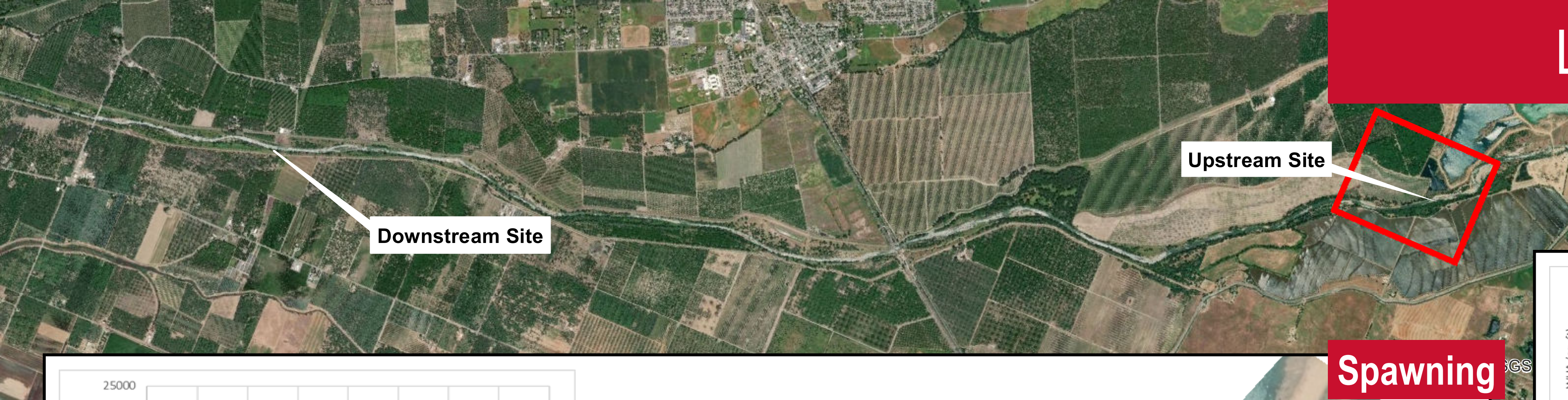


Lower Bear River - Instream Flow Study

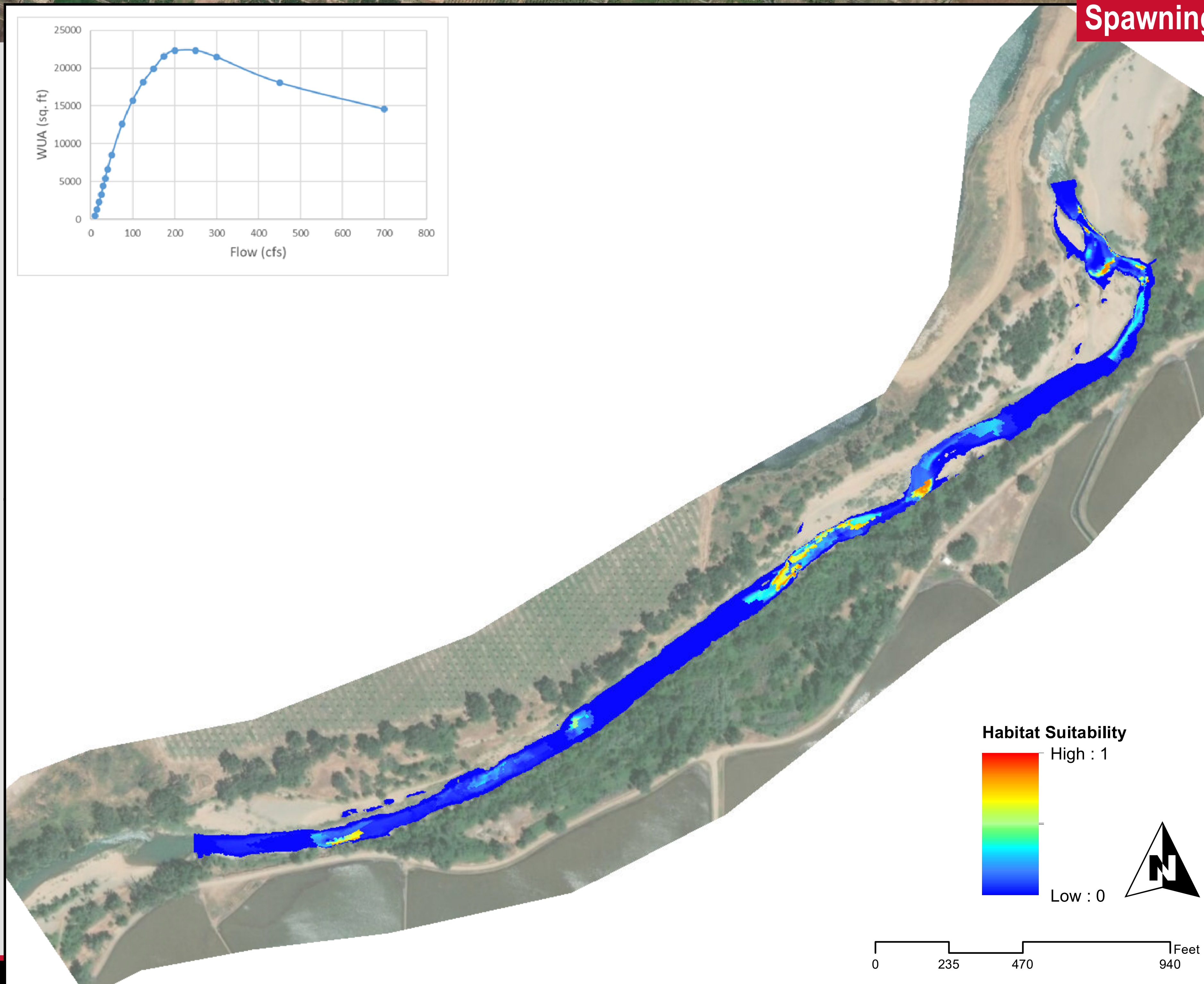
SSWD HDR

Steelhead

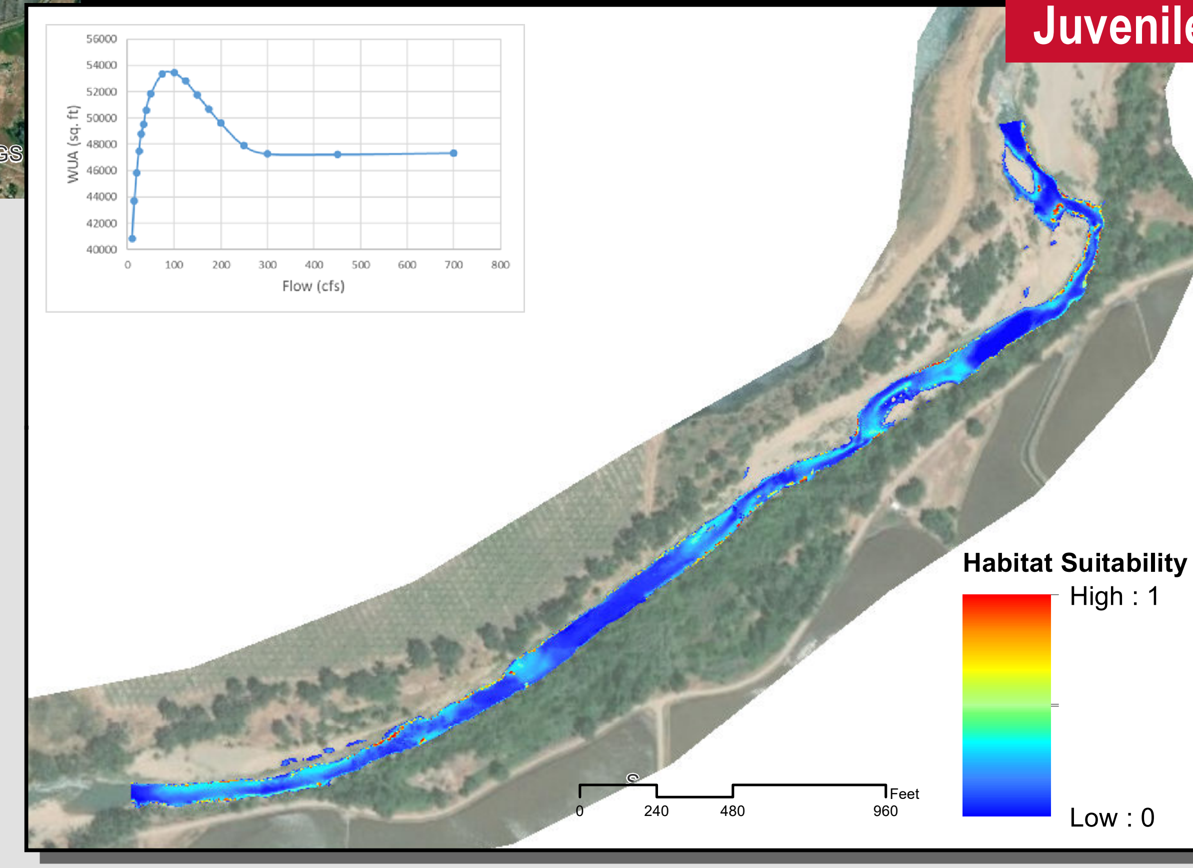
Upstream Study Site 200 cfs



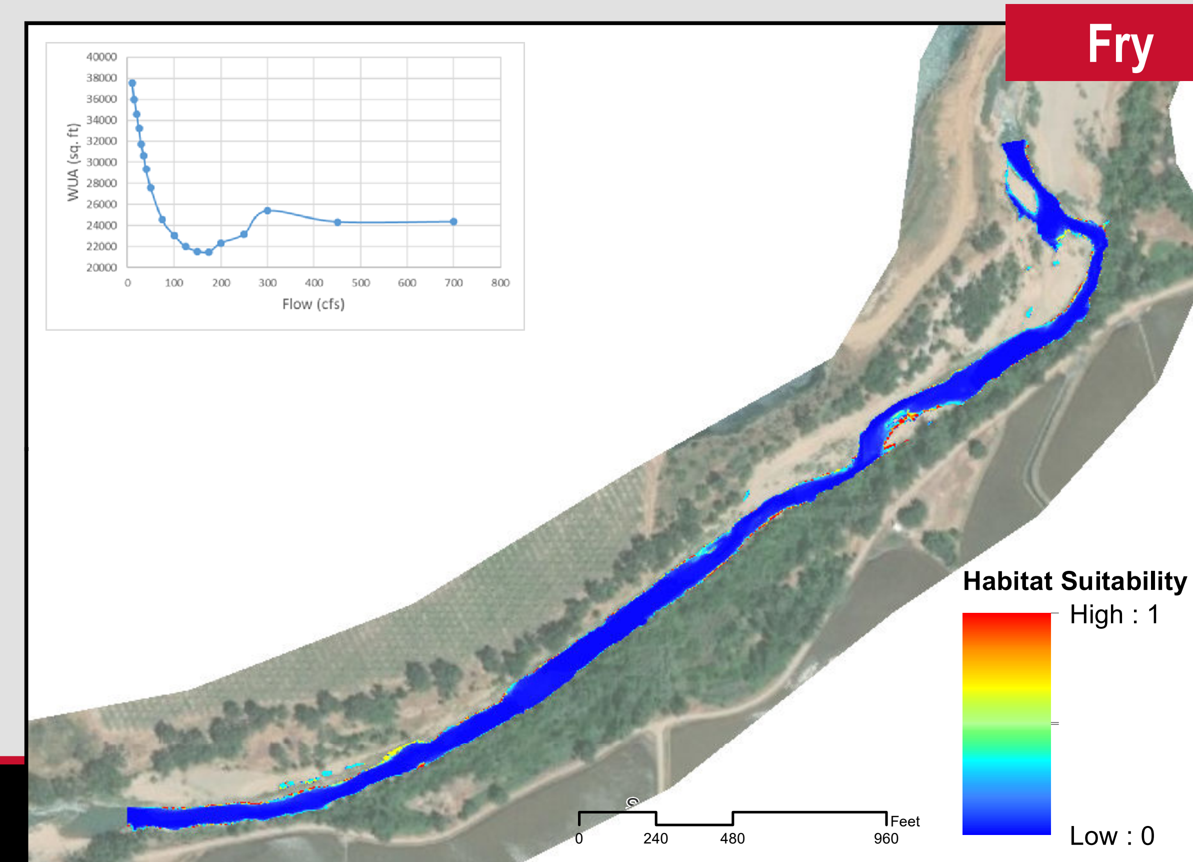
Spawning



Juvenile



Fry

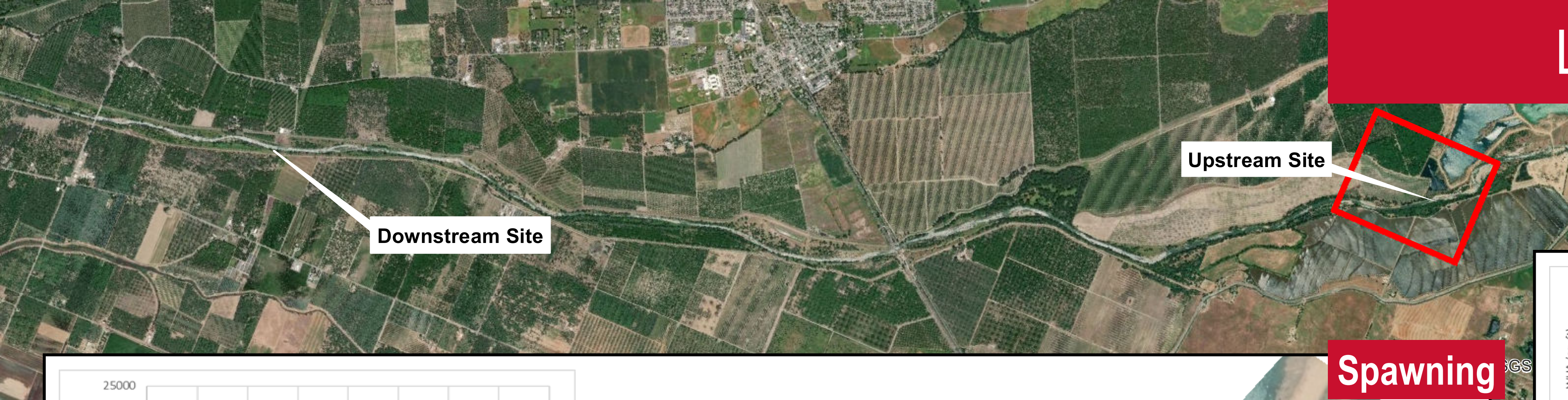


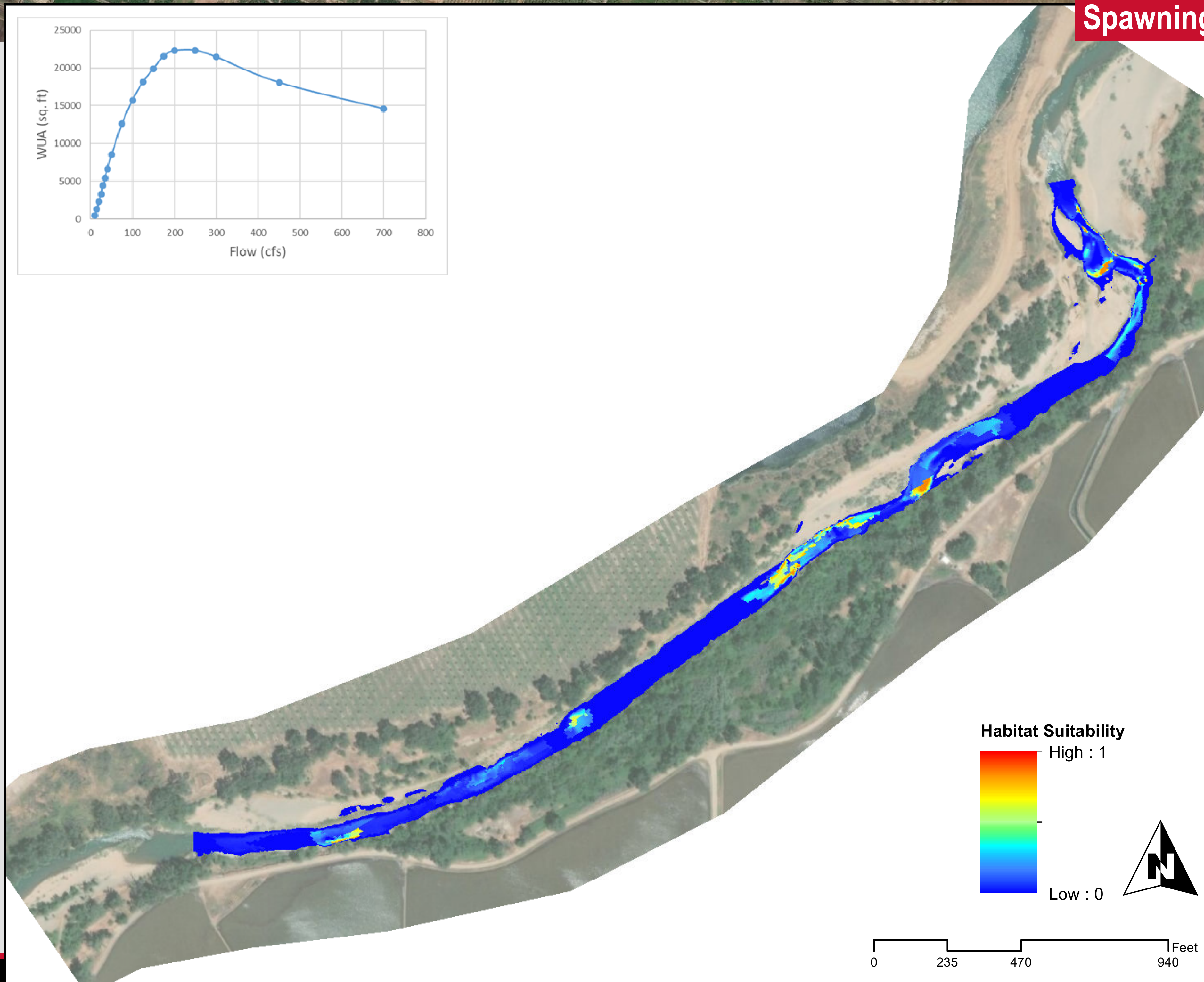
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

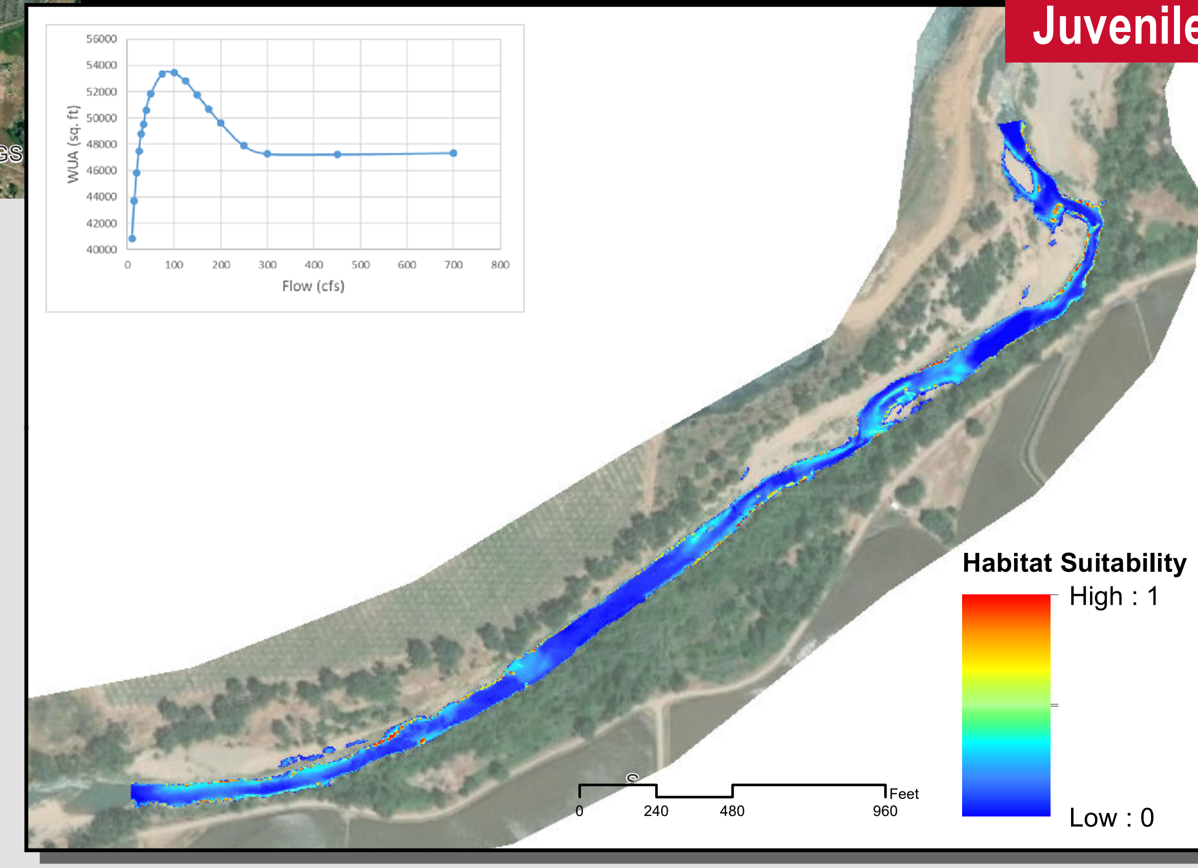
Lower Bear River - Instream Flow Study

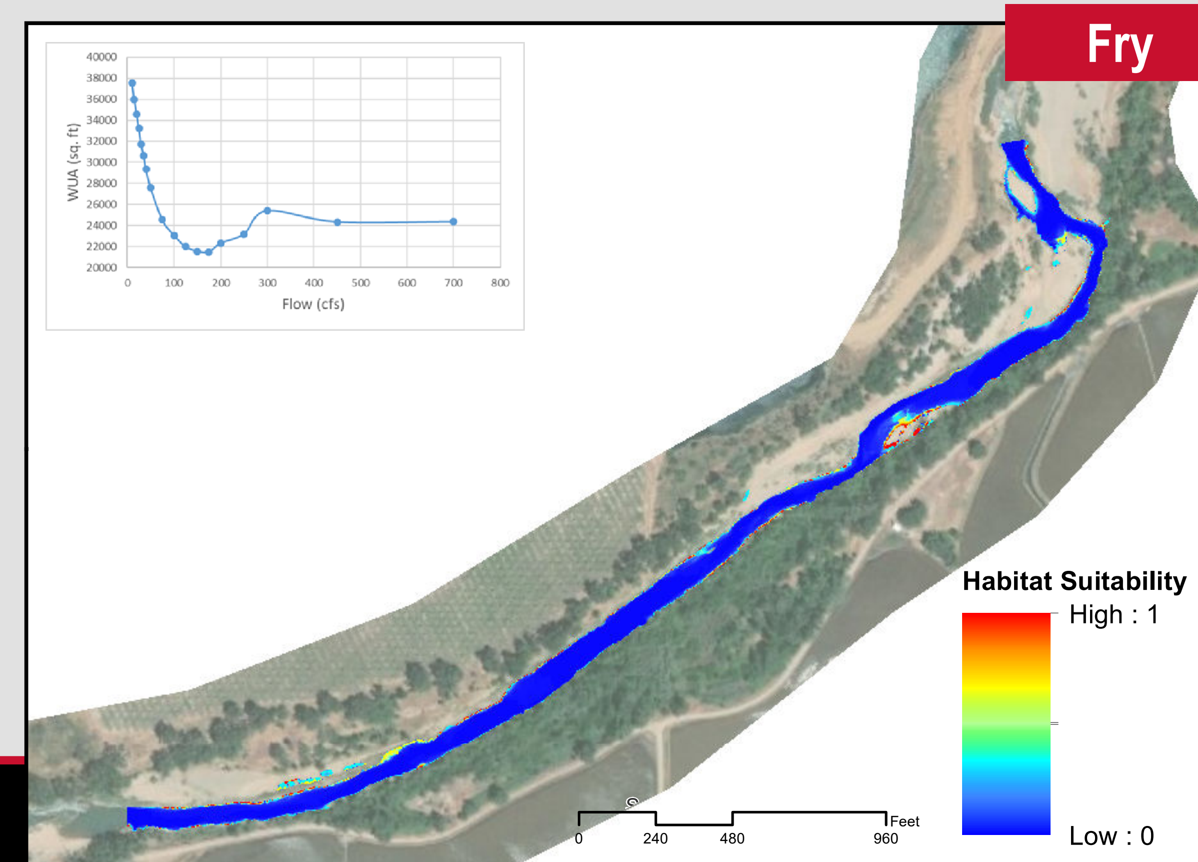
Steelhead

Upstream Study Site 250 cfs







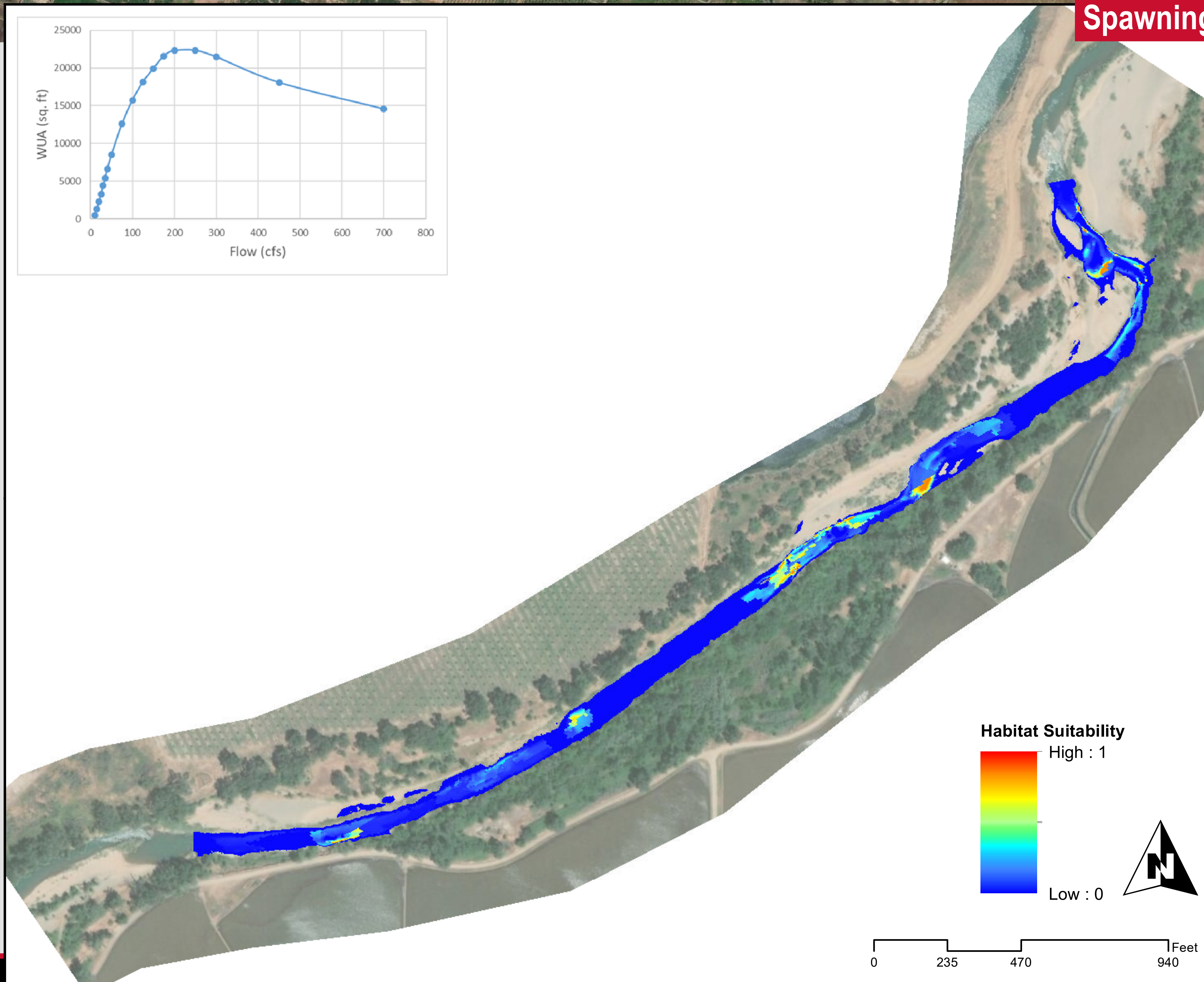


Lower Bear River - Instream Flow Study

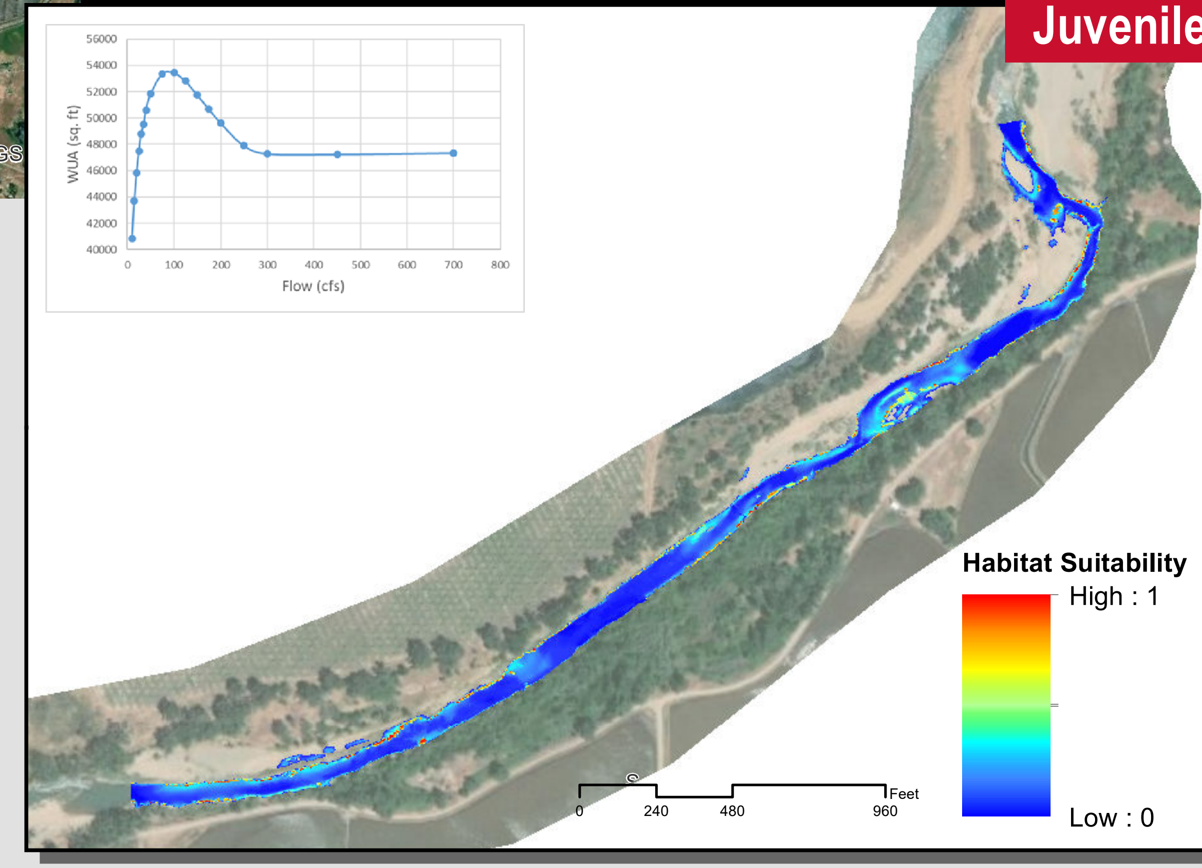
SSWD HDR

Steelhead
Upstream Study Site 300 cfs

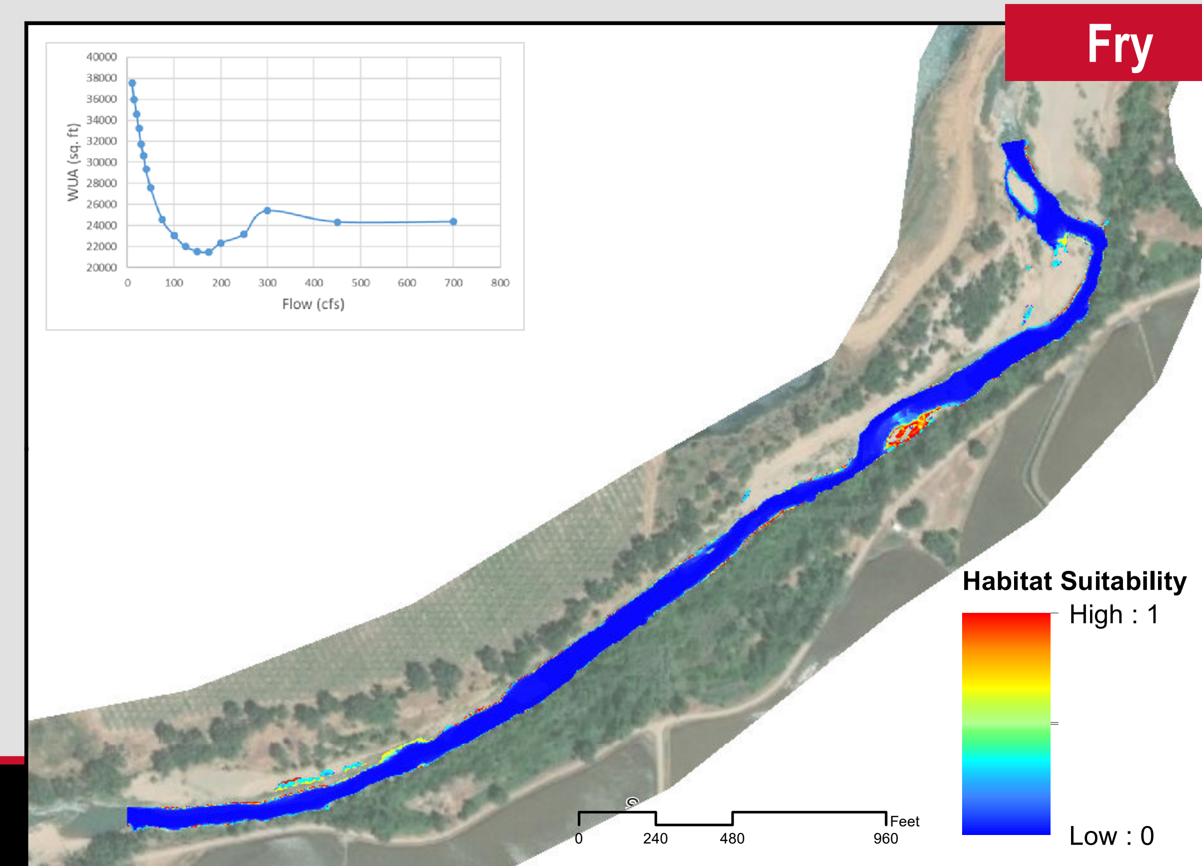
Spawning



Juvenile



Fry

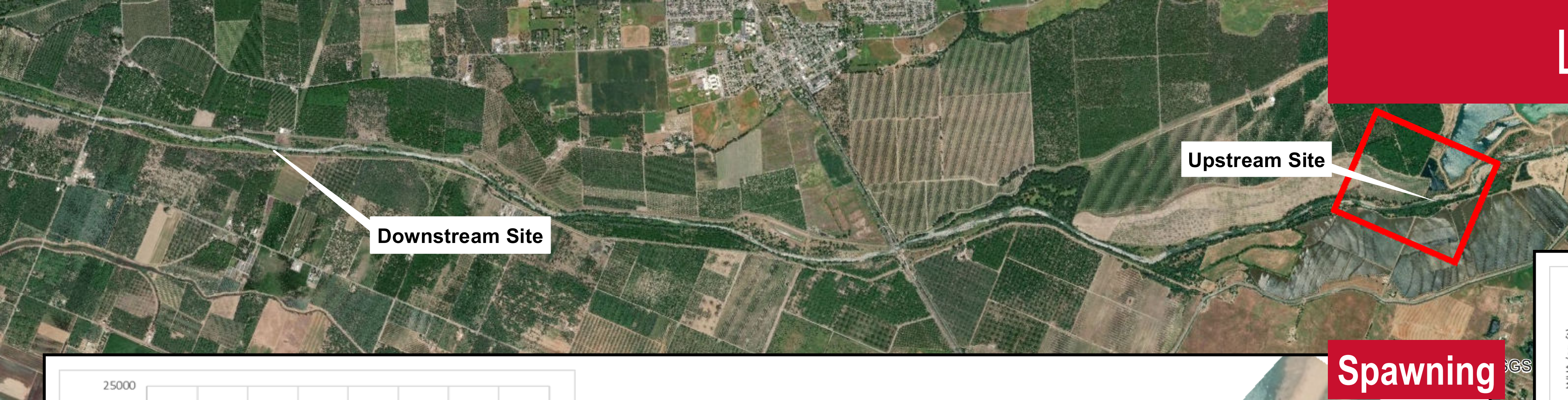


Lower Bear River - Instream Flow Study

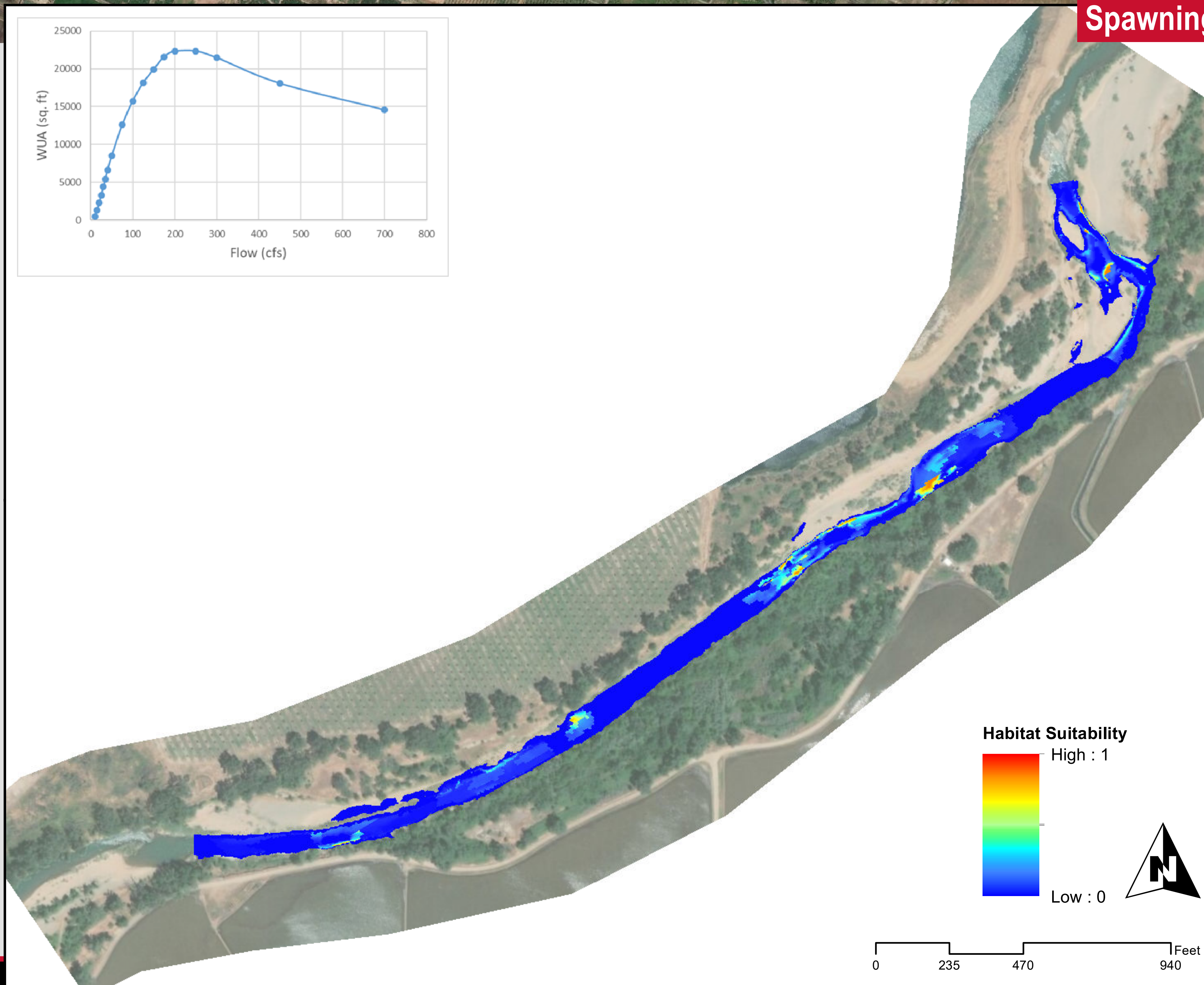
SSWD HDR

Steelhead

Upstream Study Site 450 cfs



Spawning



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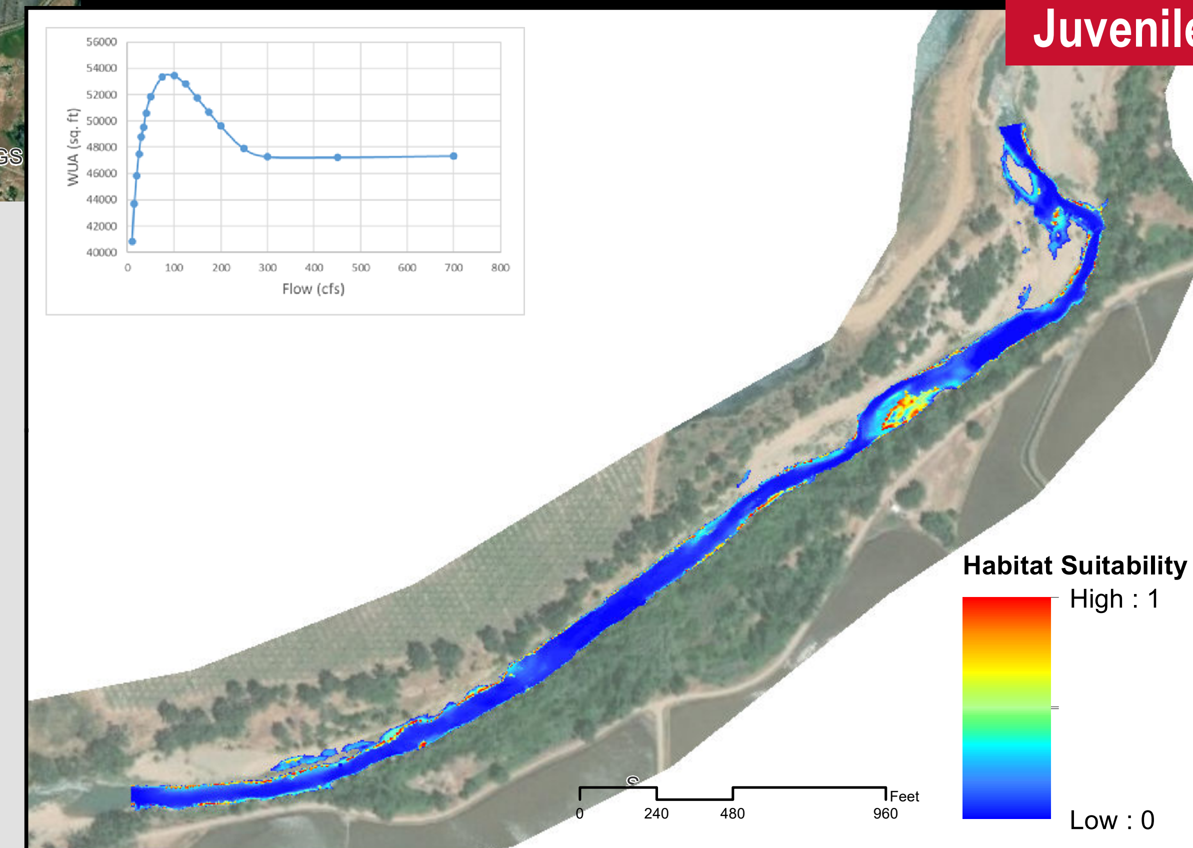

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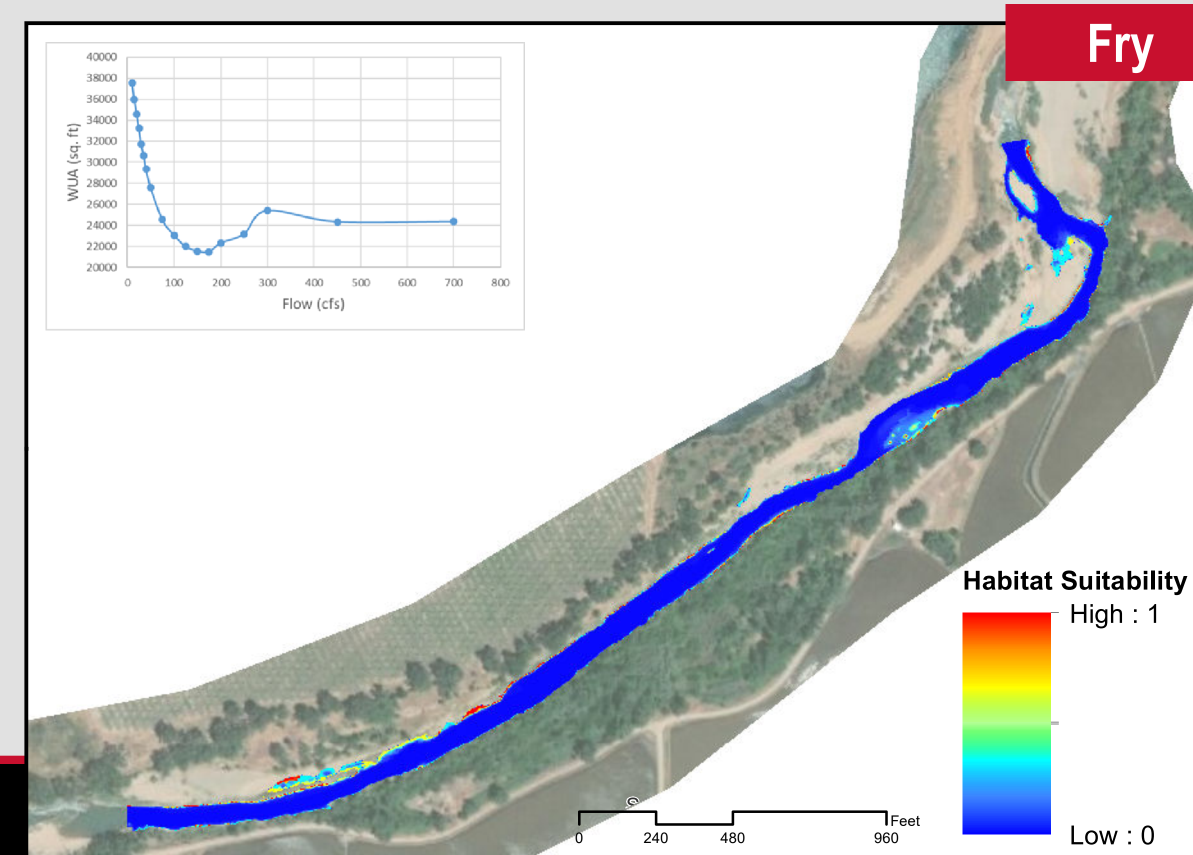
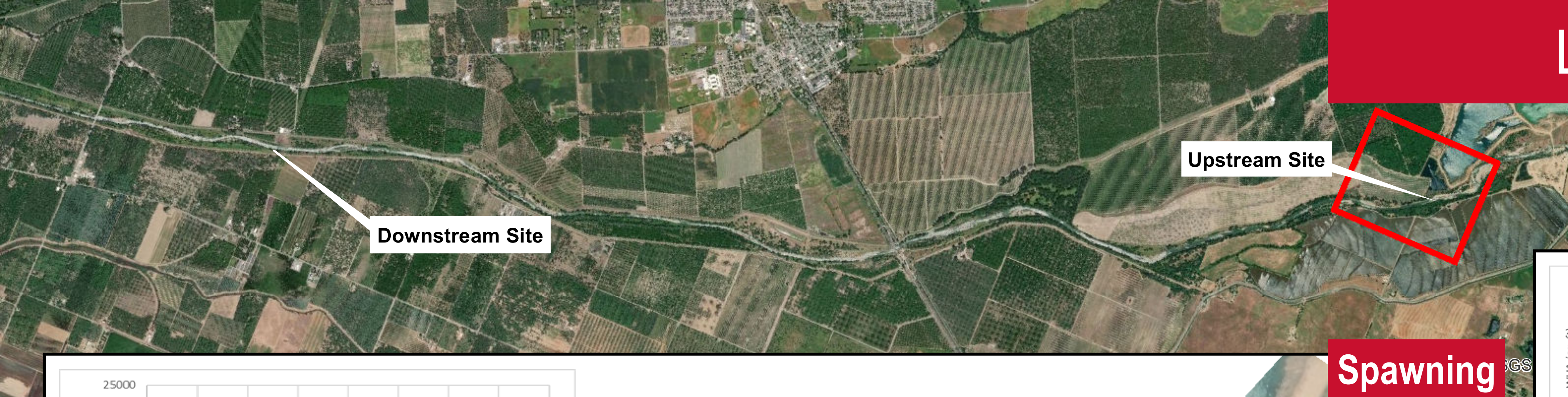


Lower Bear River - Instream Flow Study

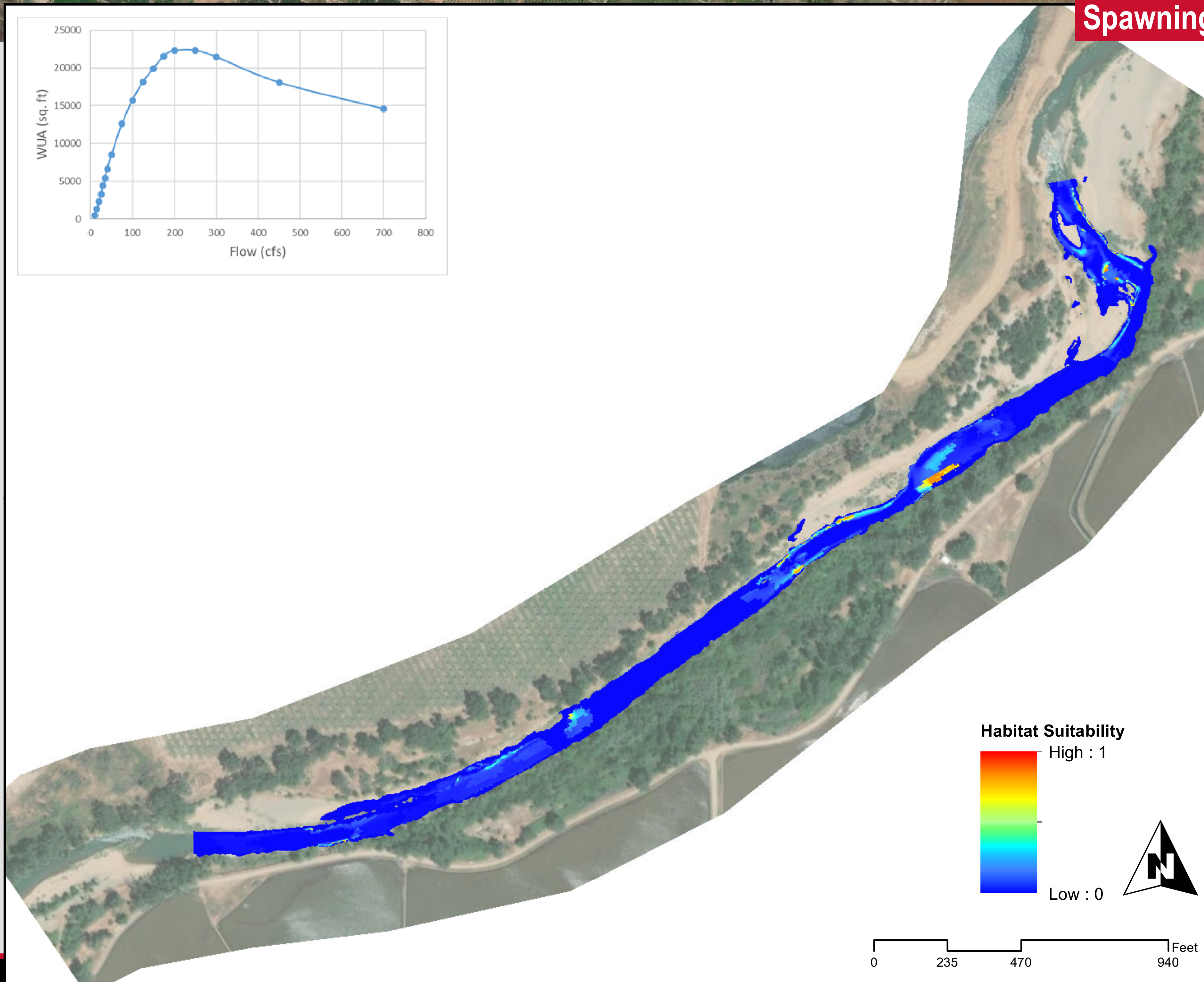
SSWD HDR

Steelhead

Upstream Study Site 700 cfs



Spawning



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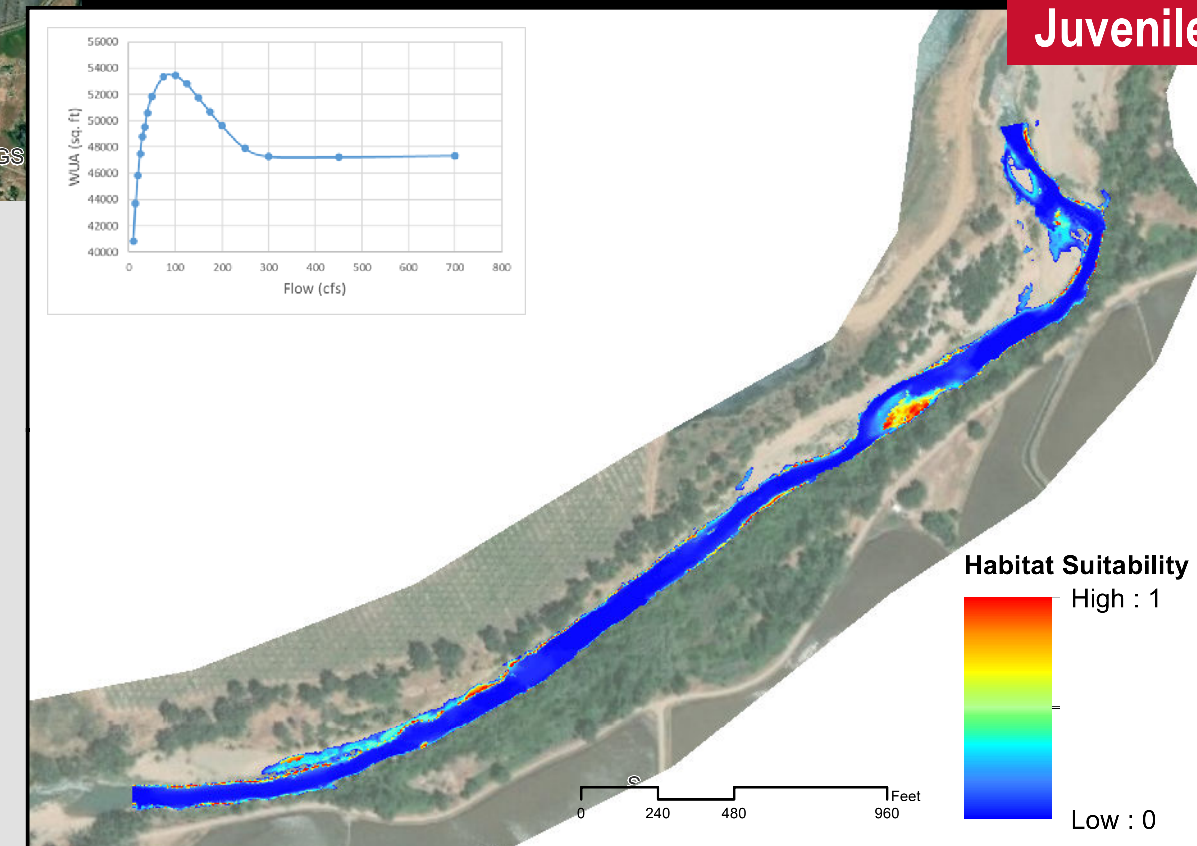

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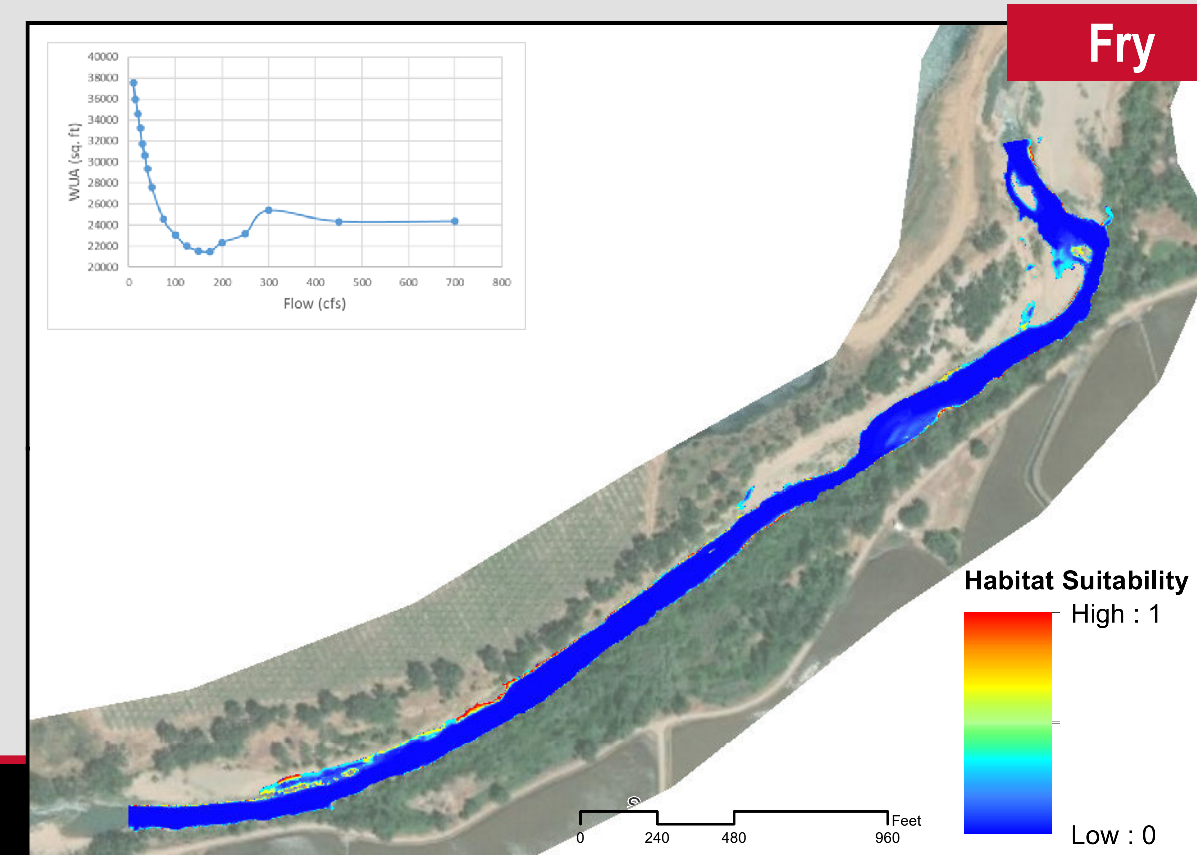
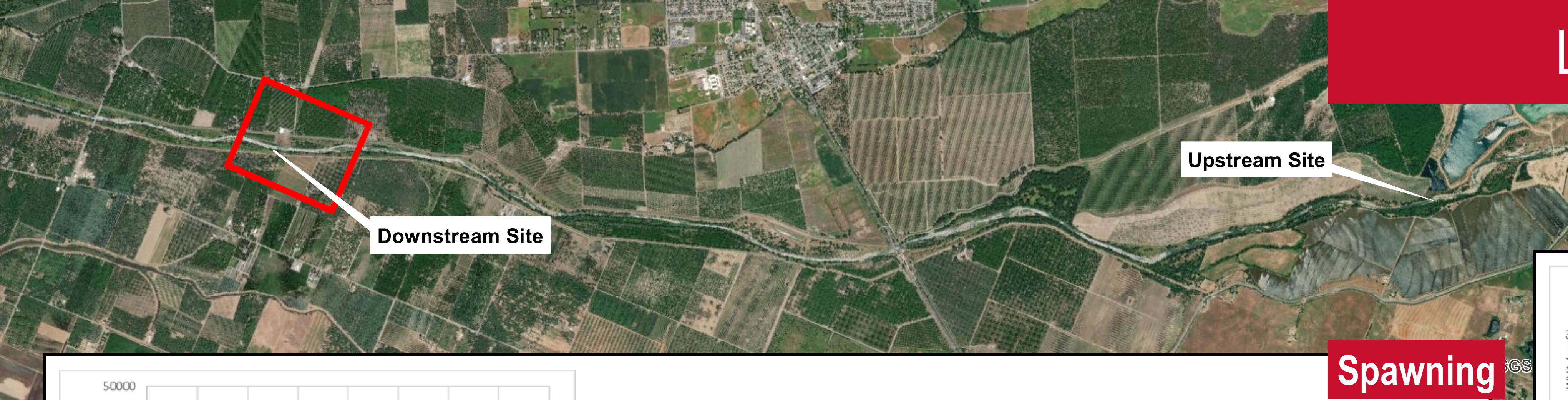


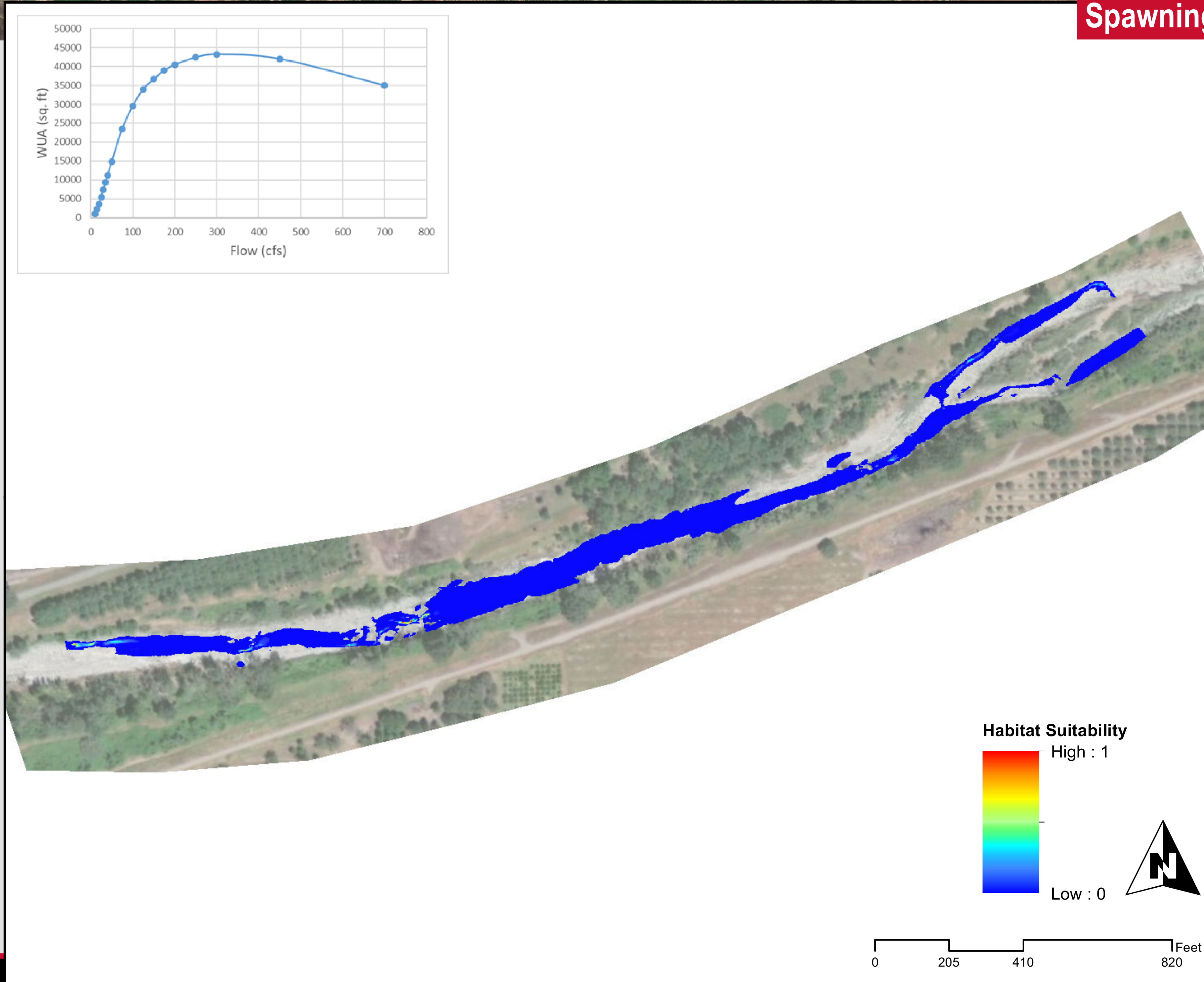
Lower Bear River - Instream Flow Study

Steelhead

Downstream Study Site 10 cfs



Spawning



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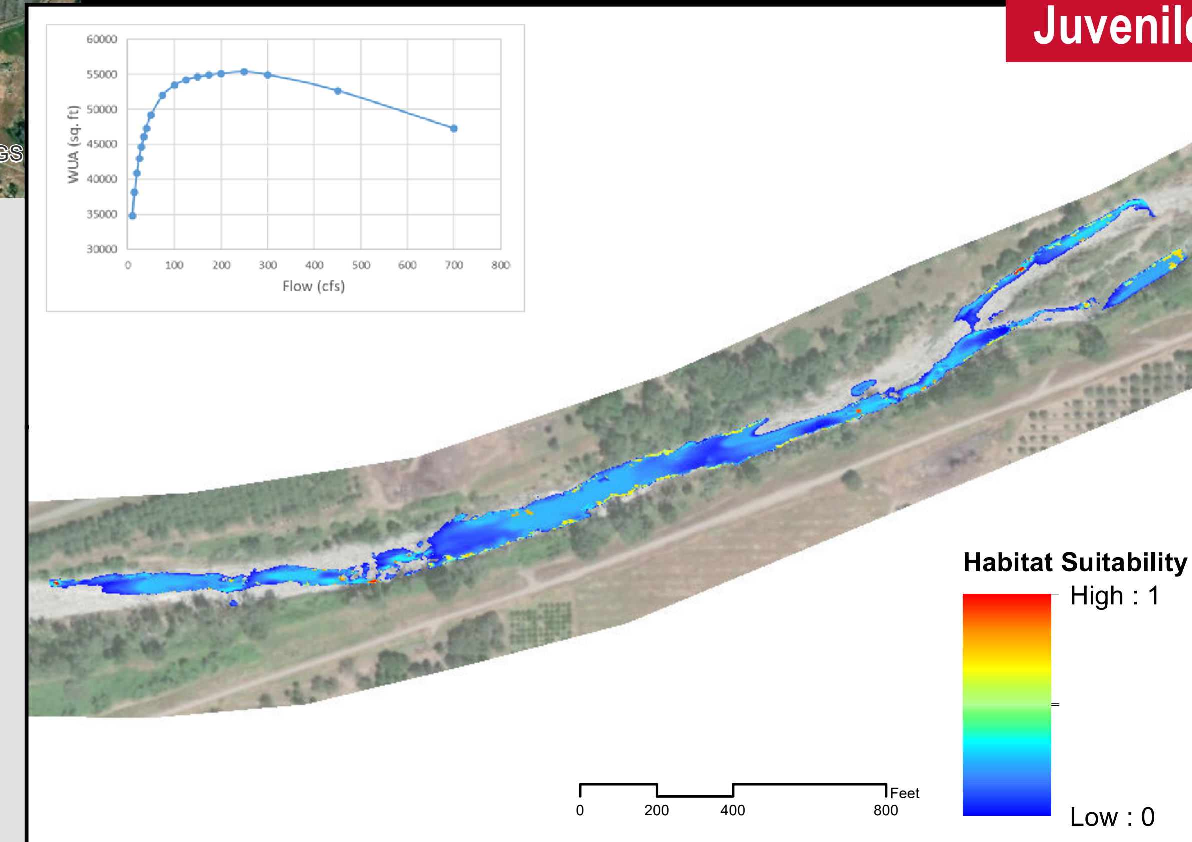

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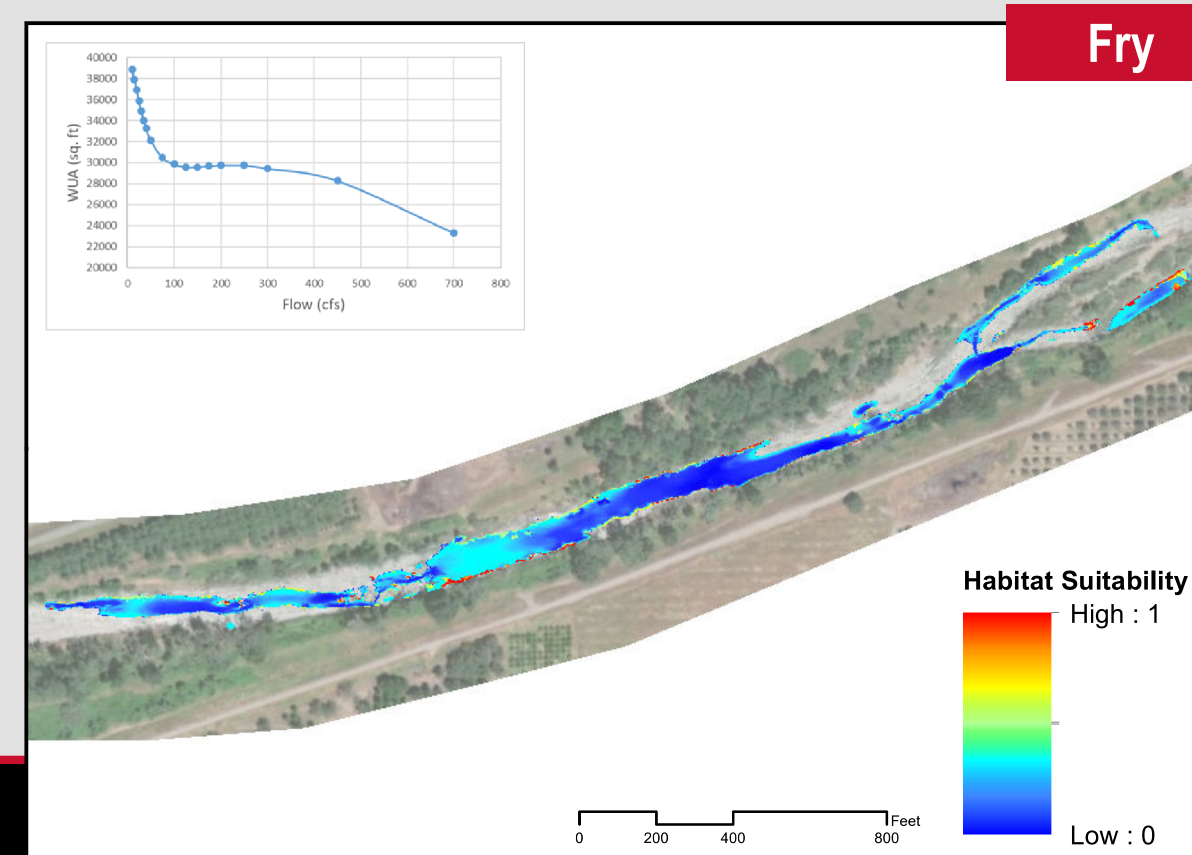
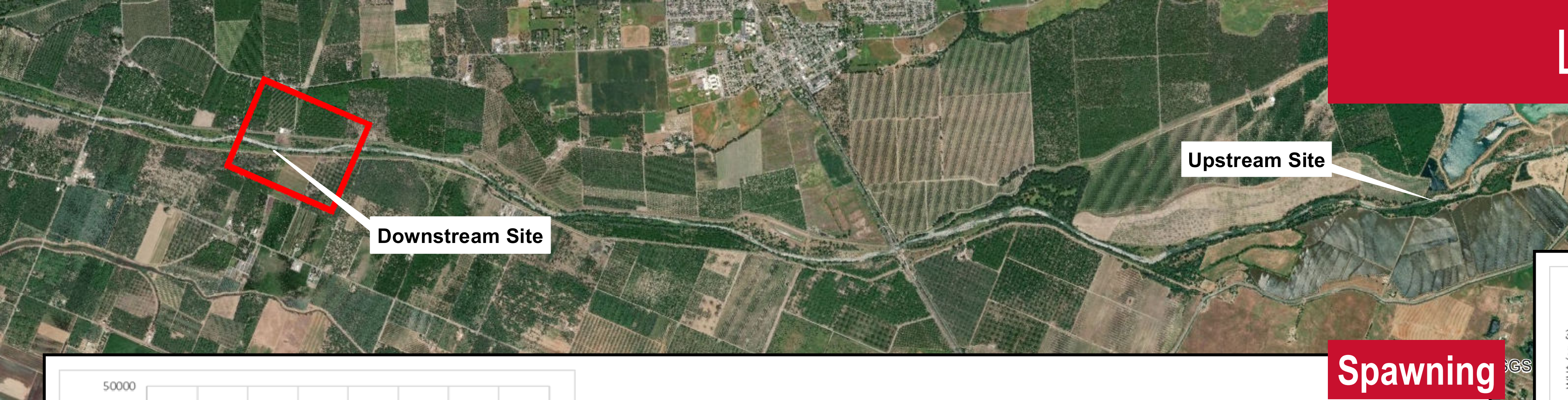


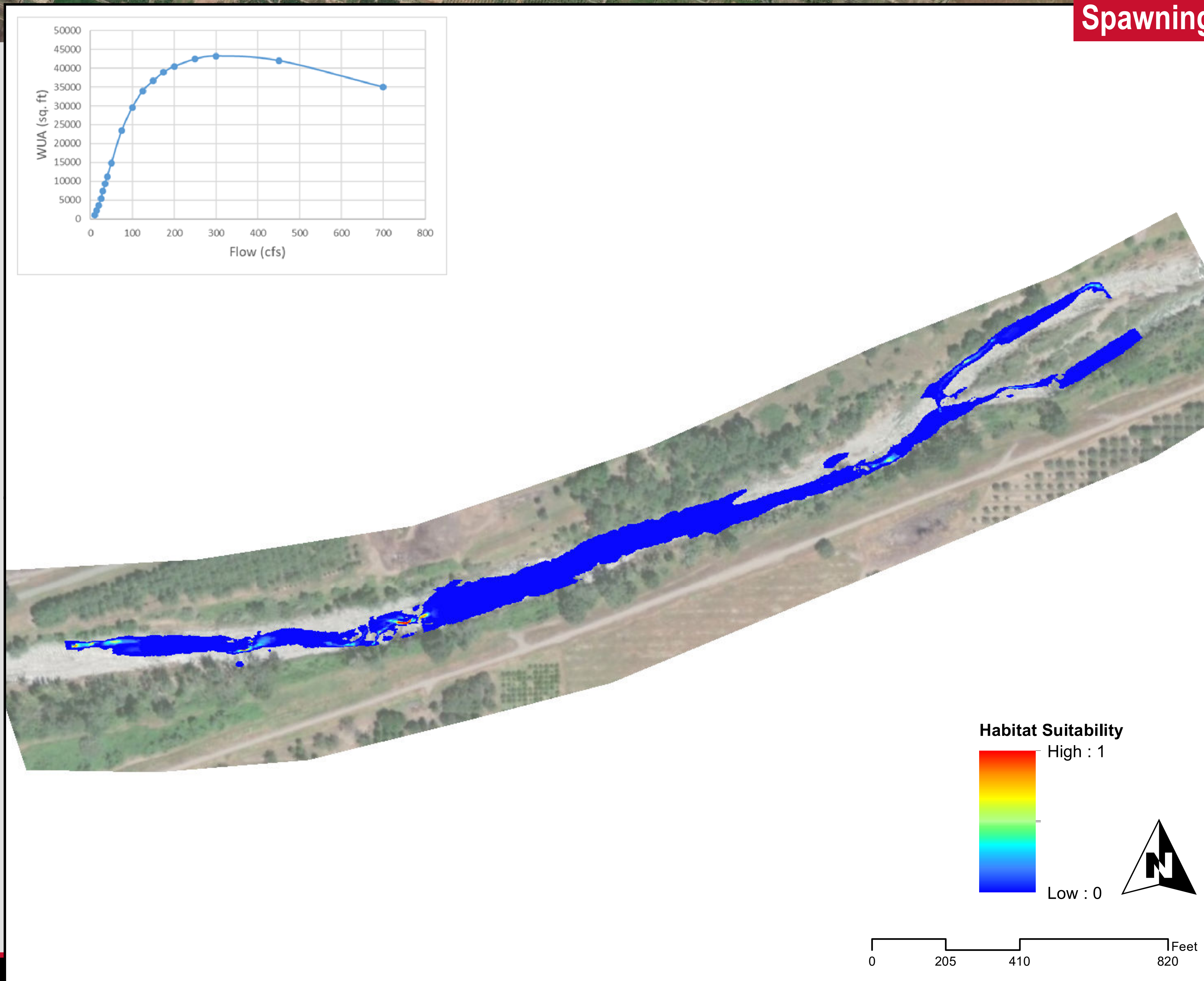
Lower Bear River - Instream Flow Study

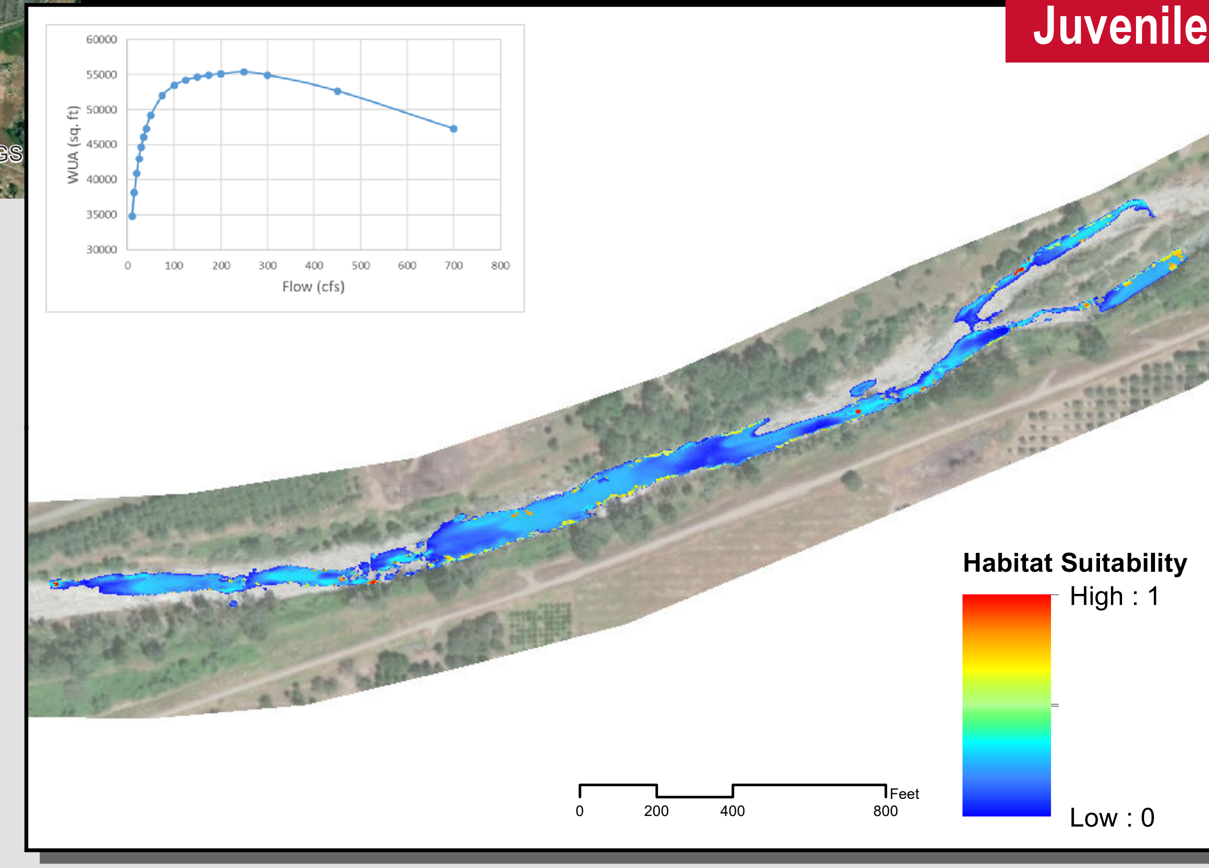
SSWD HDR

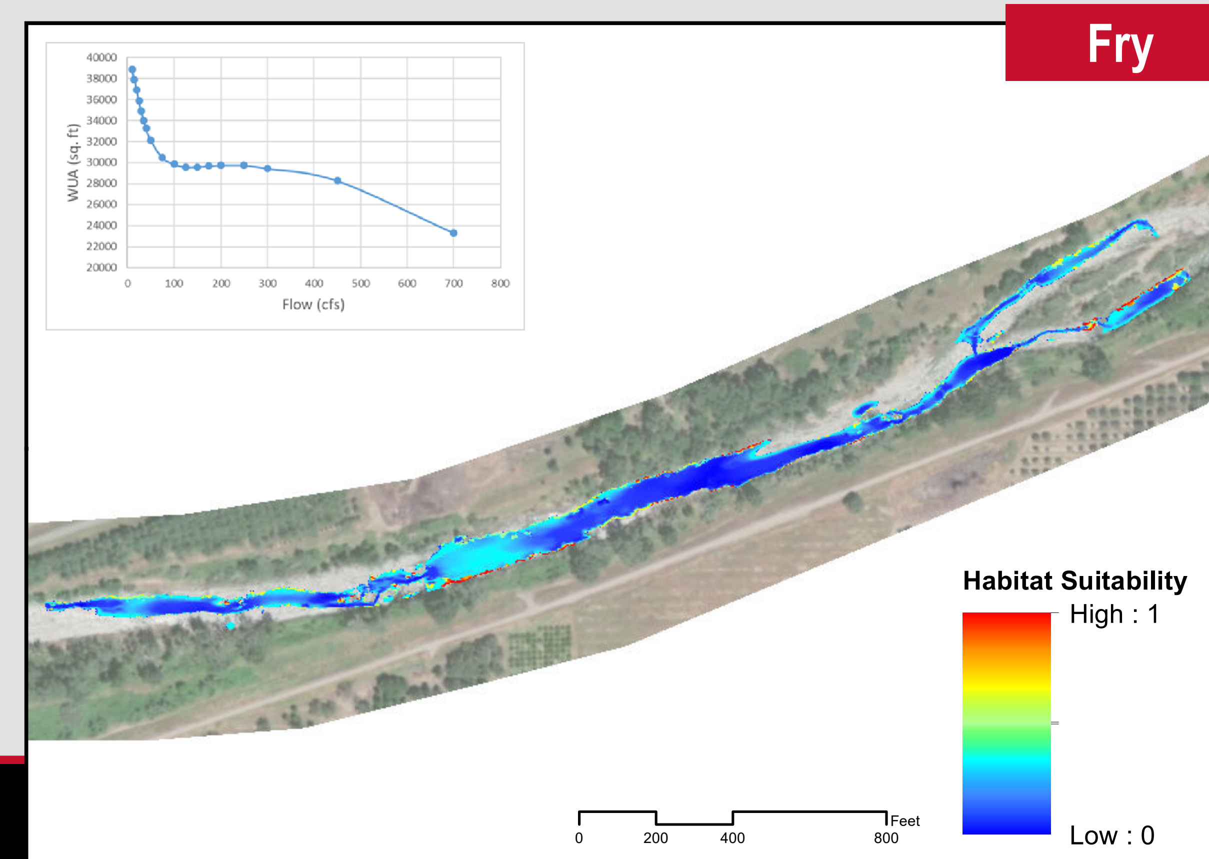
Steelhead

Downstream Study Site 15 cfs





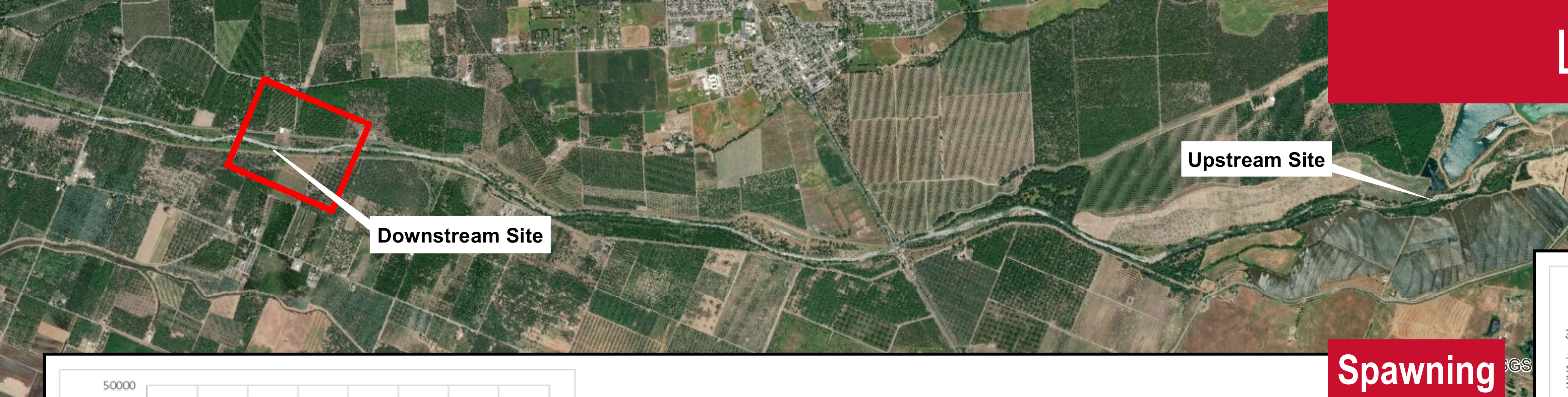




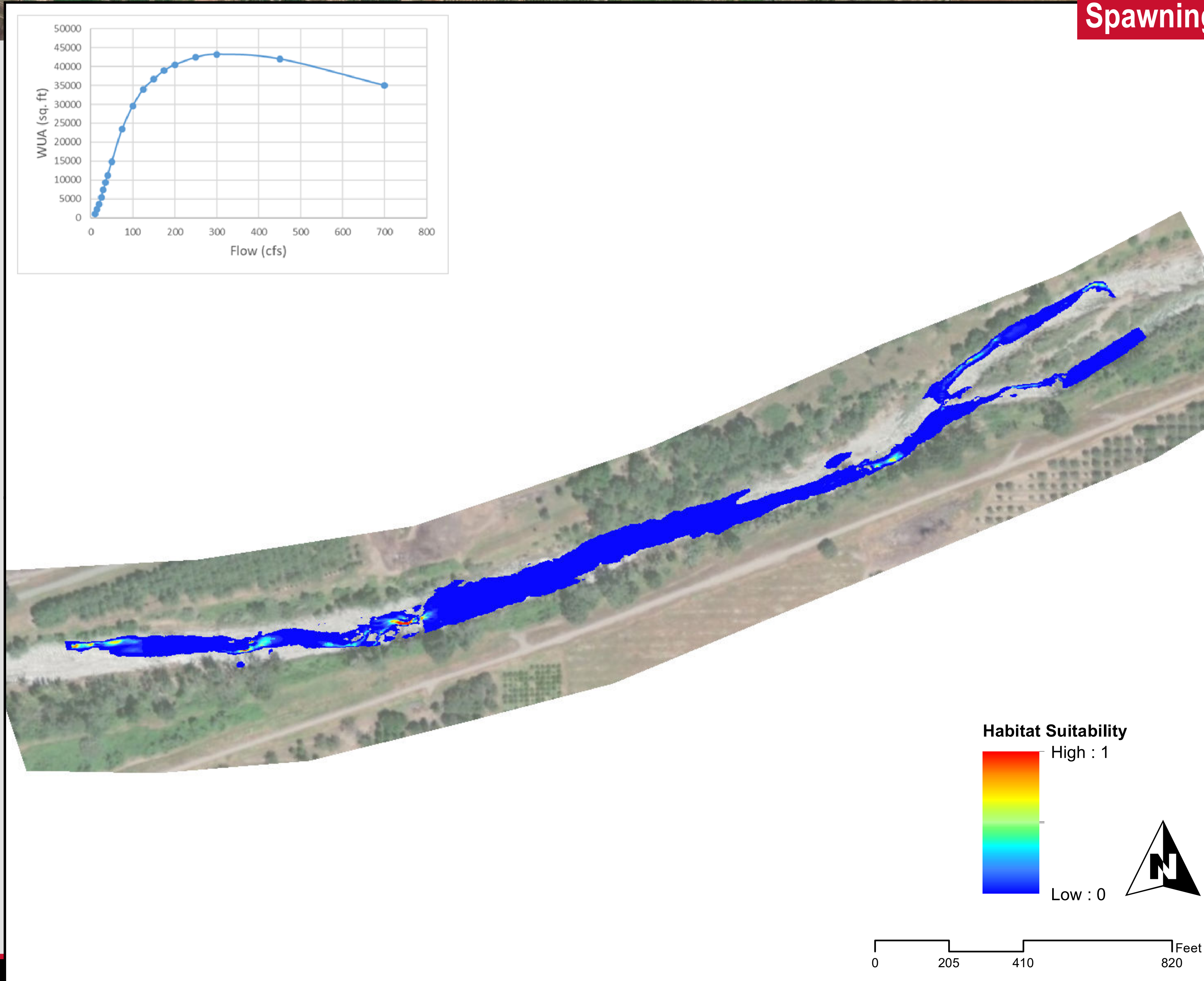
Lower Bear River - Instream Flow Study

Steelhead

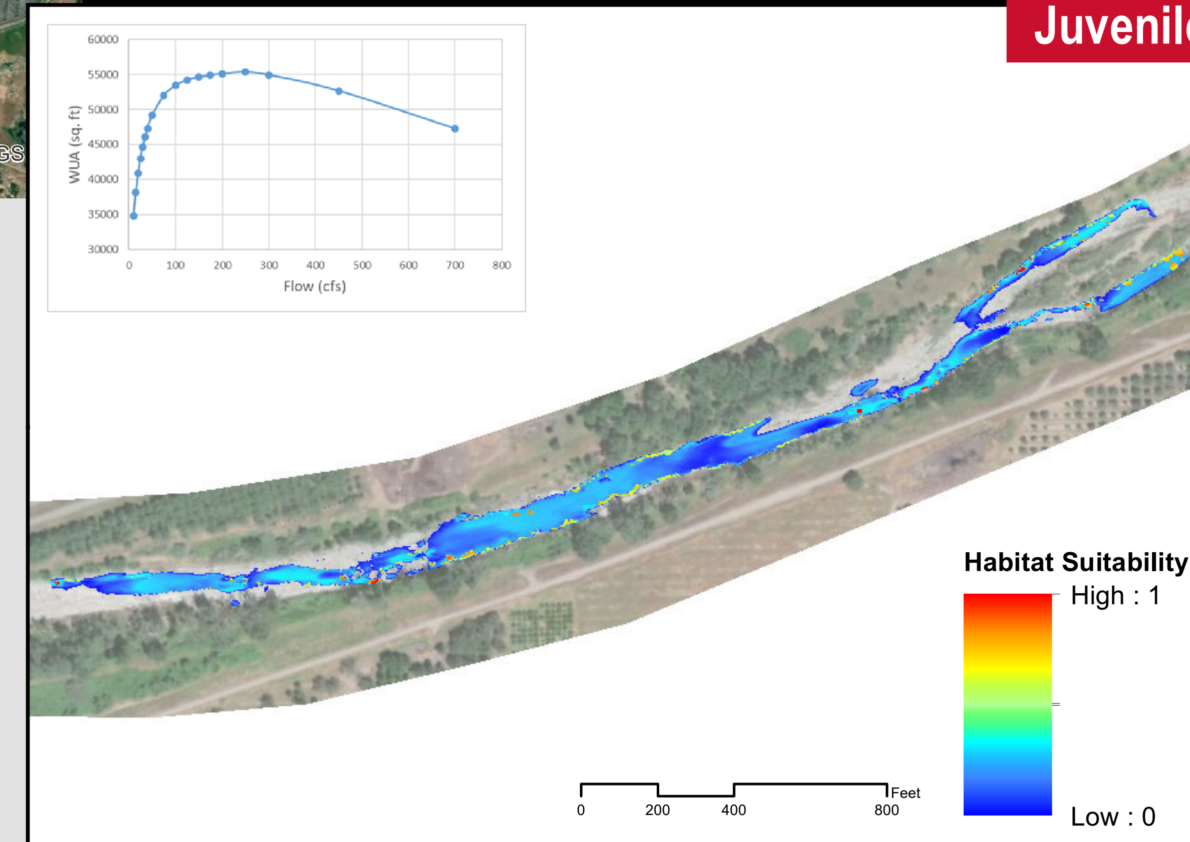
Downstream Study Site 20 cfs



Spawning



Juvenile



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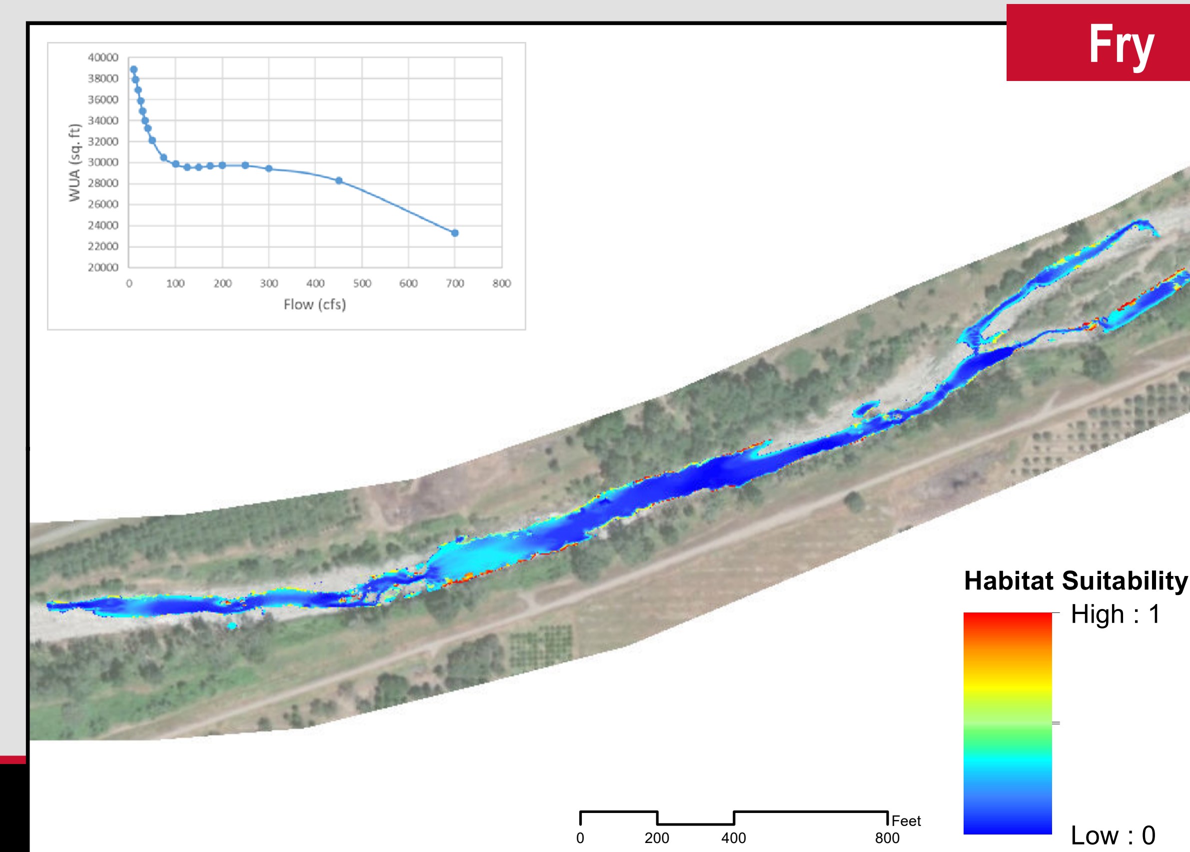


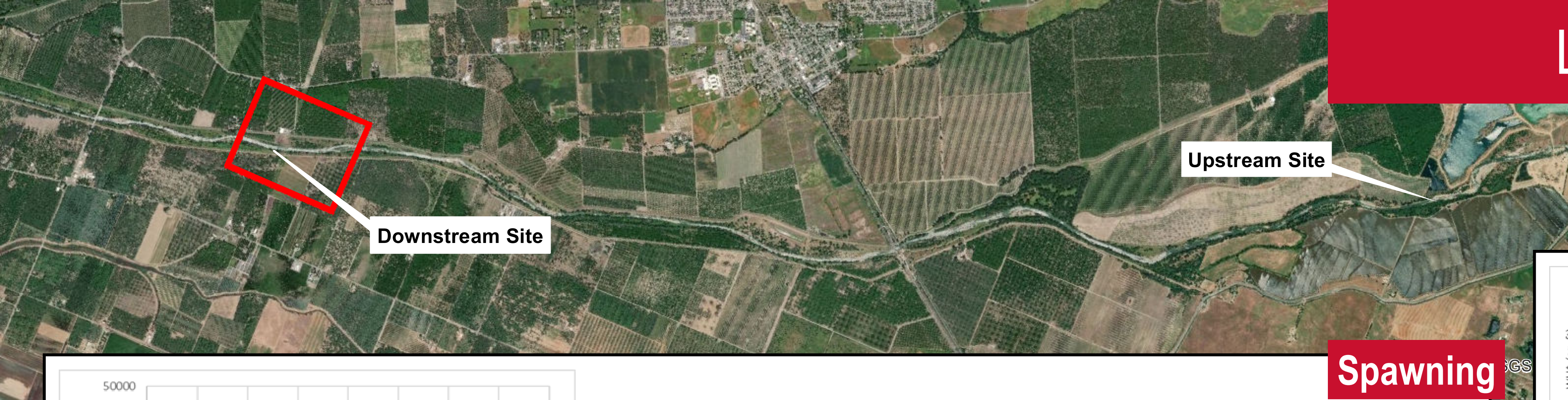
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

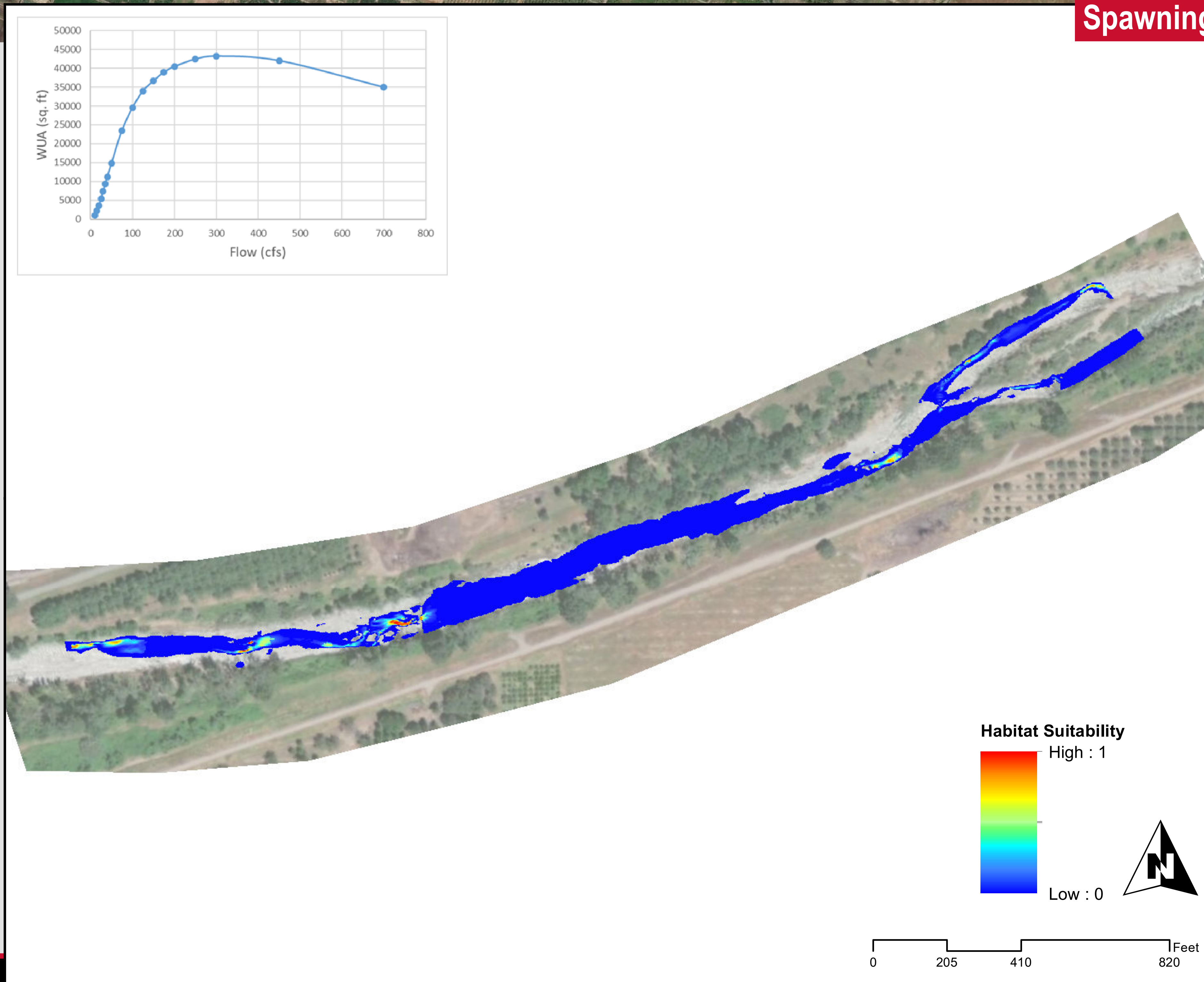
SSWD HDR

Steelhead

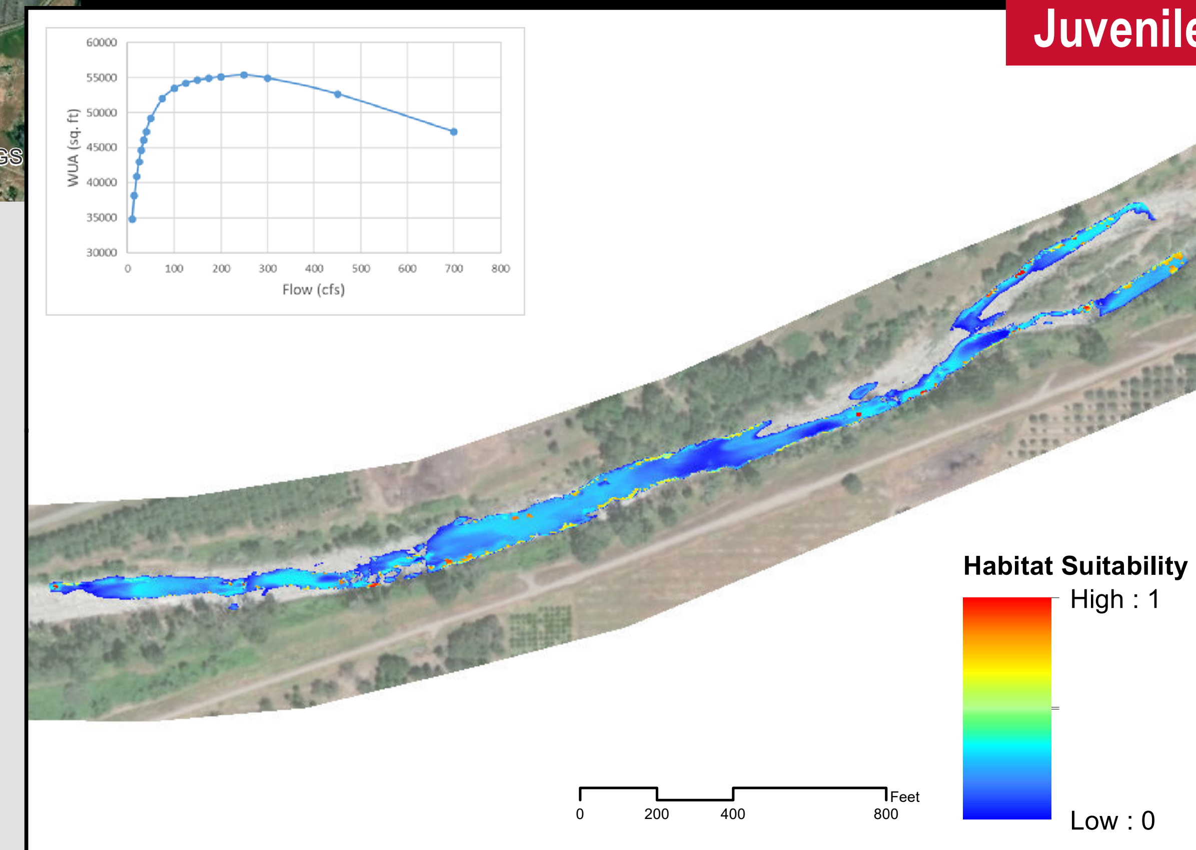
Downstream Study Site 25 cfs



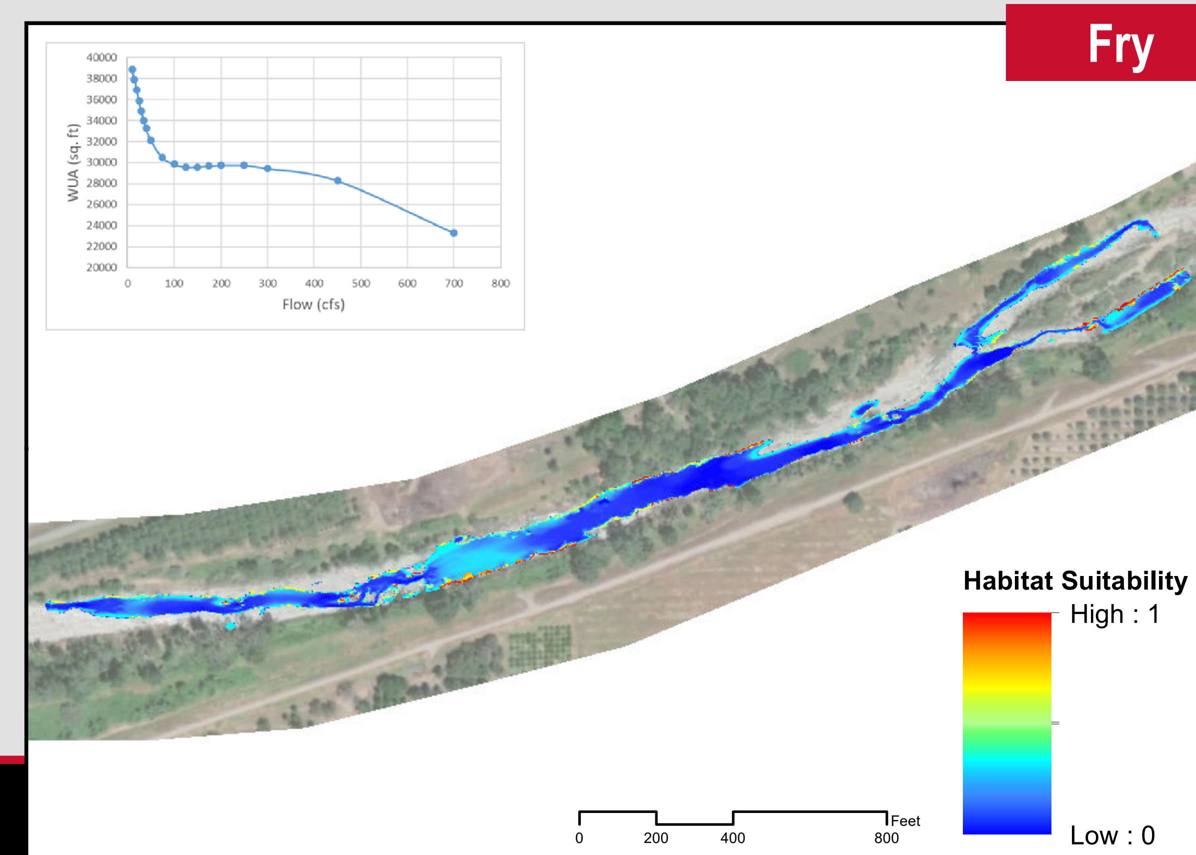
Spawning



Juvenile



Fry



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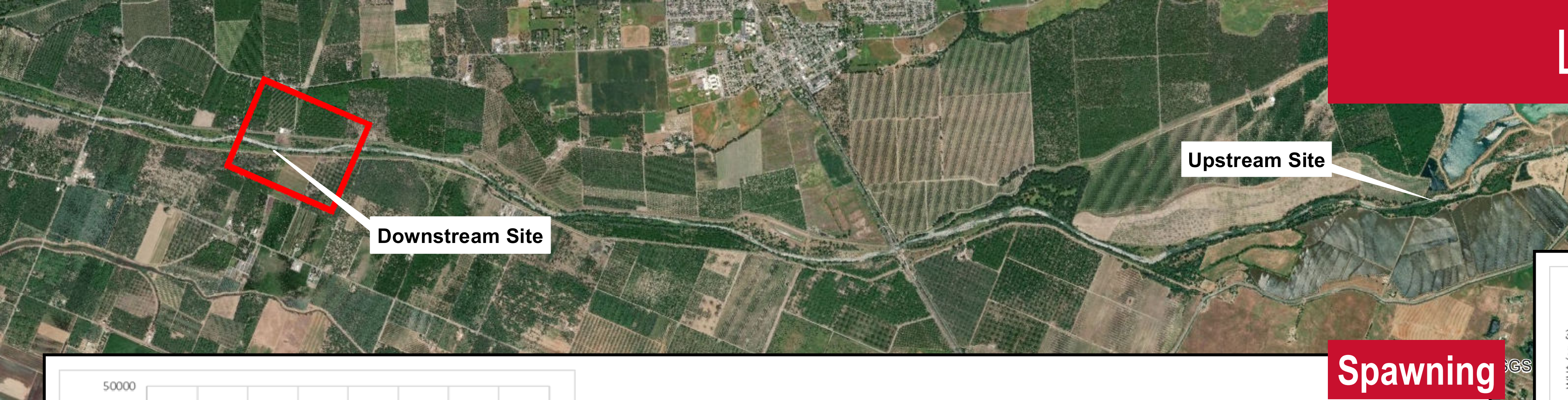
Lower Bear River - Instream Flow Study

SSWD HDR

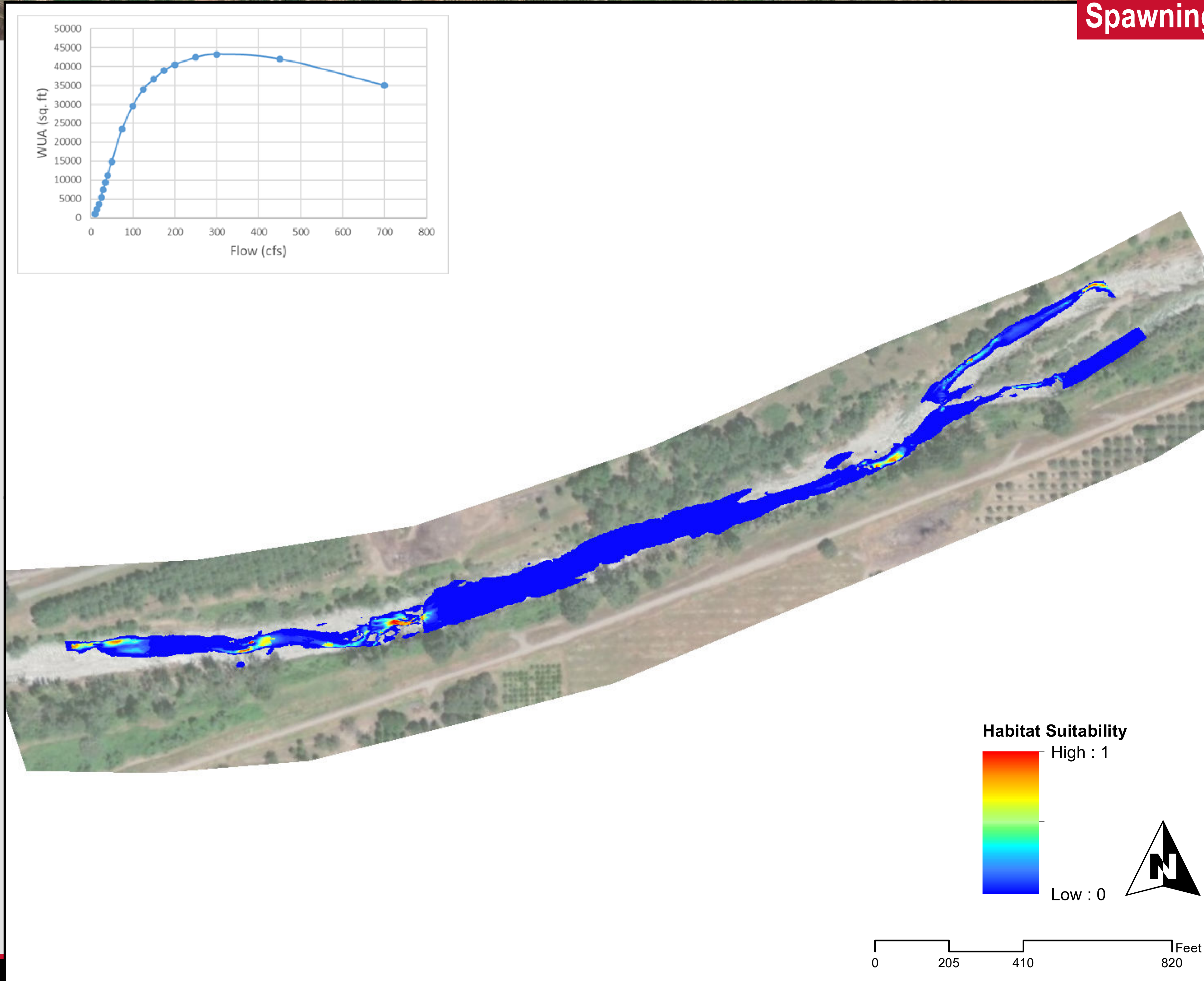
Downstream Study Site

Steelhead

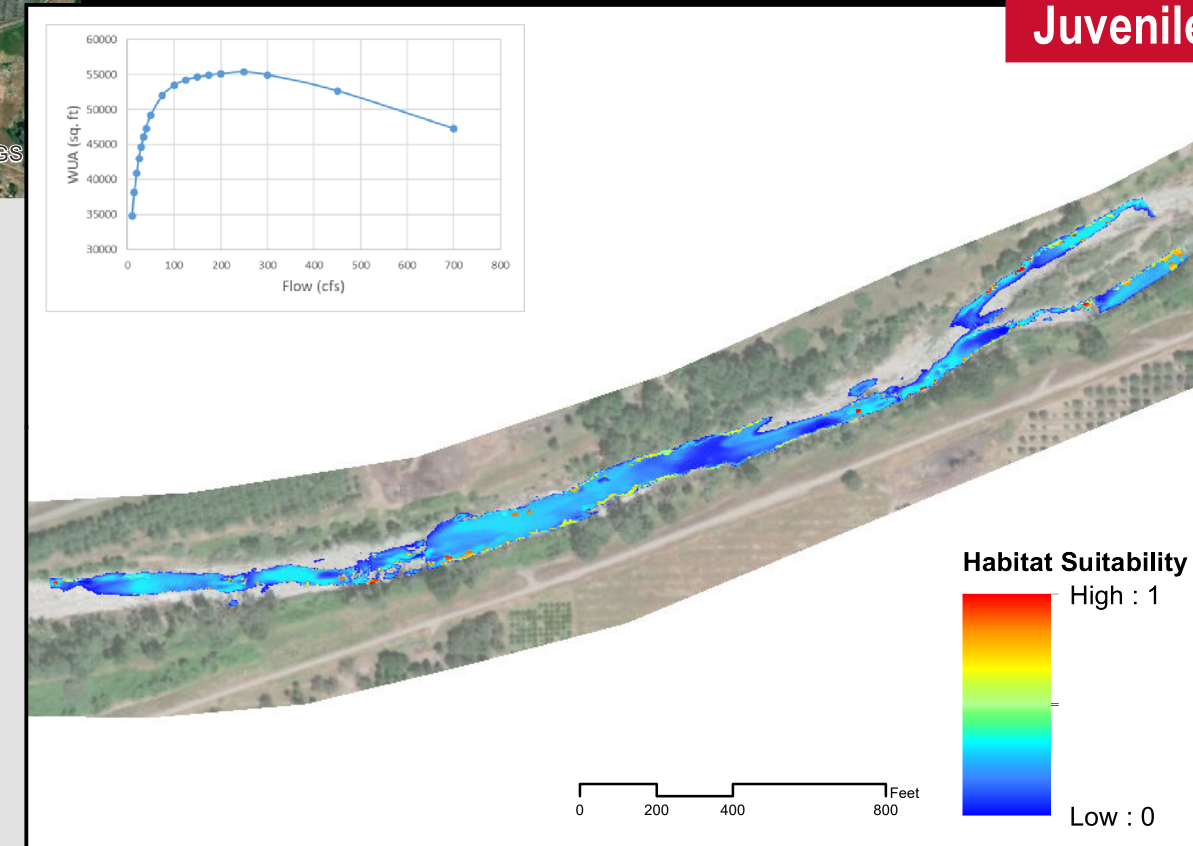
30 cfs



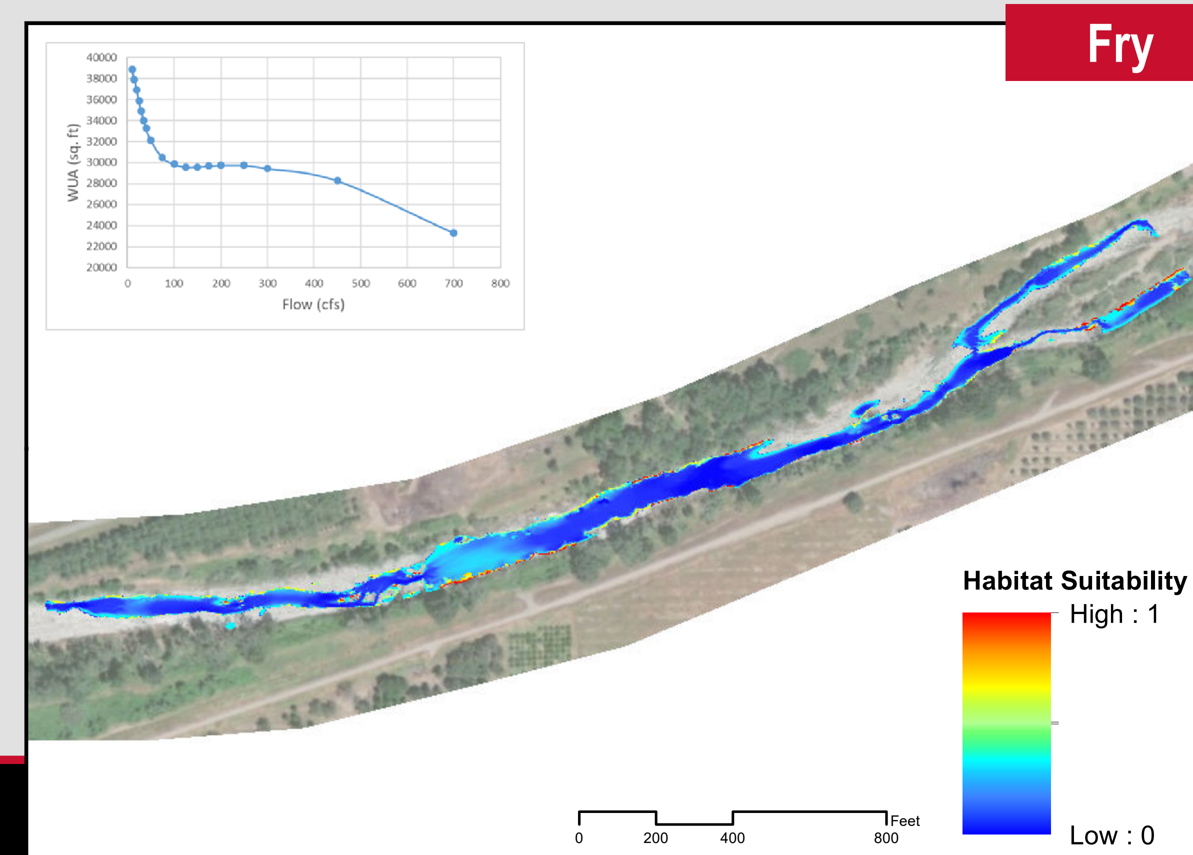
Spawning

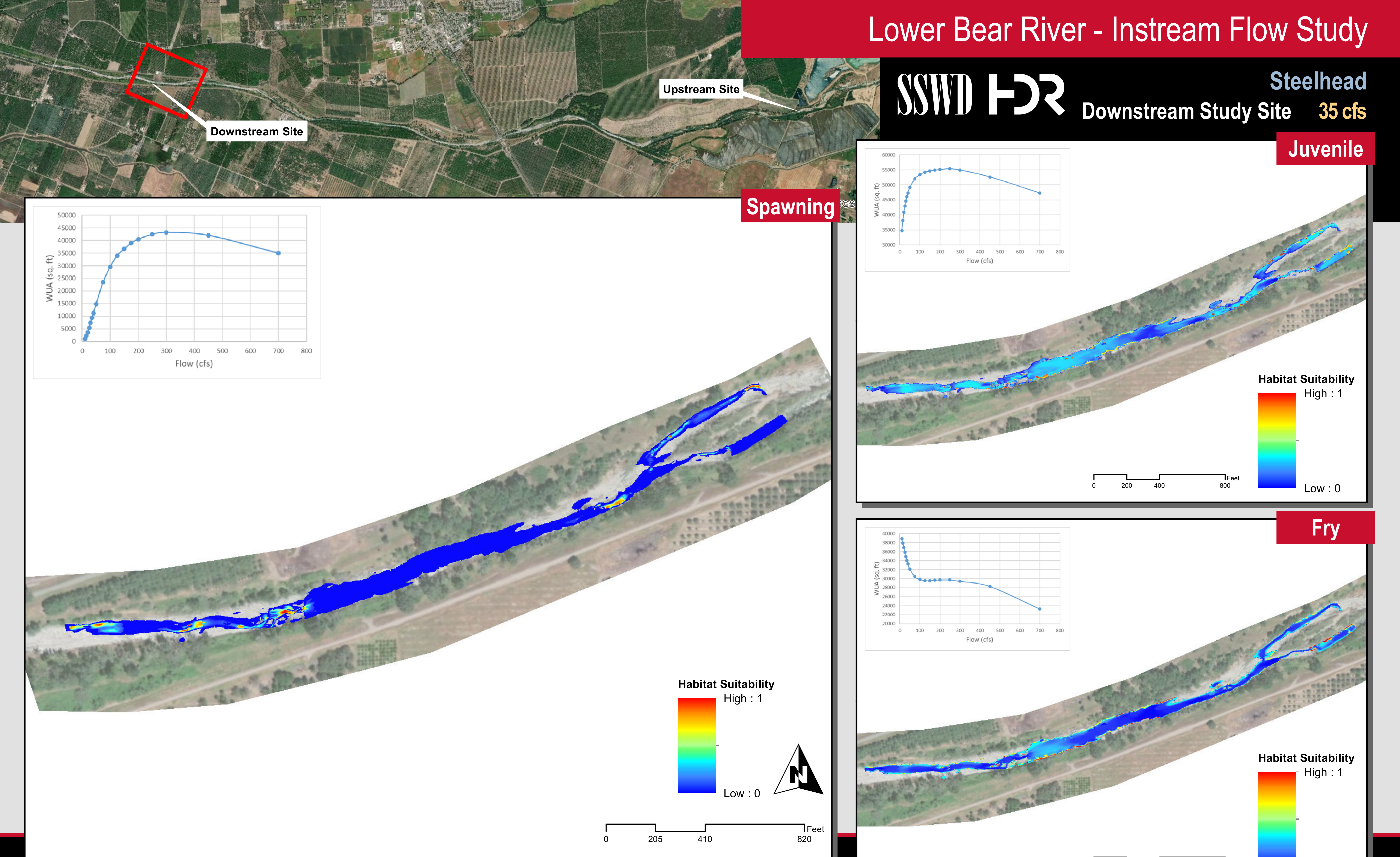


Juvenile



Fry





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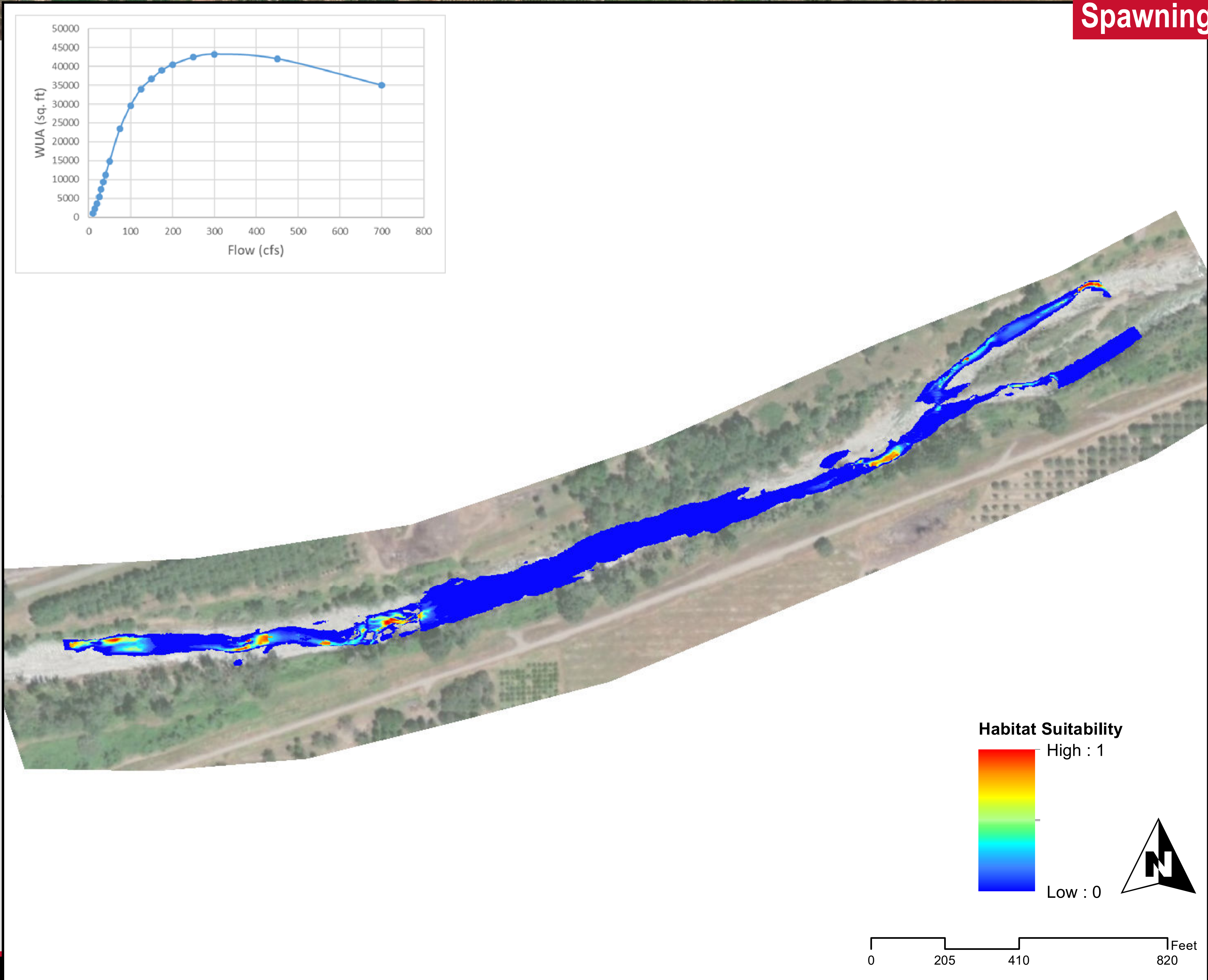
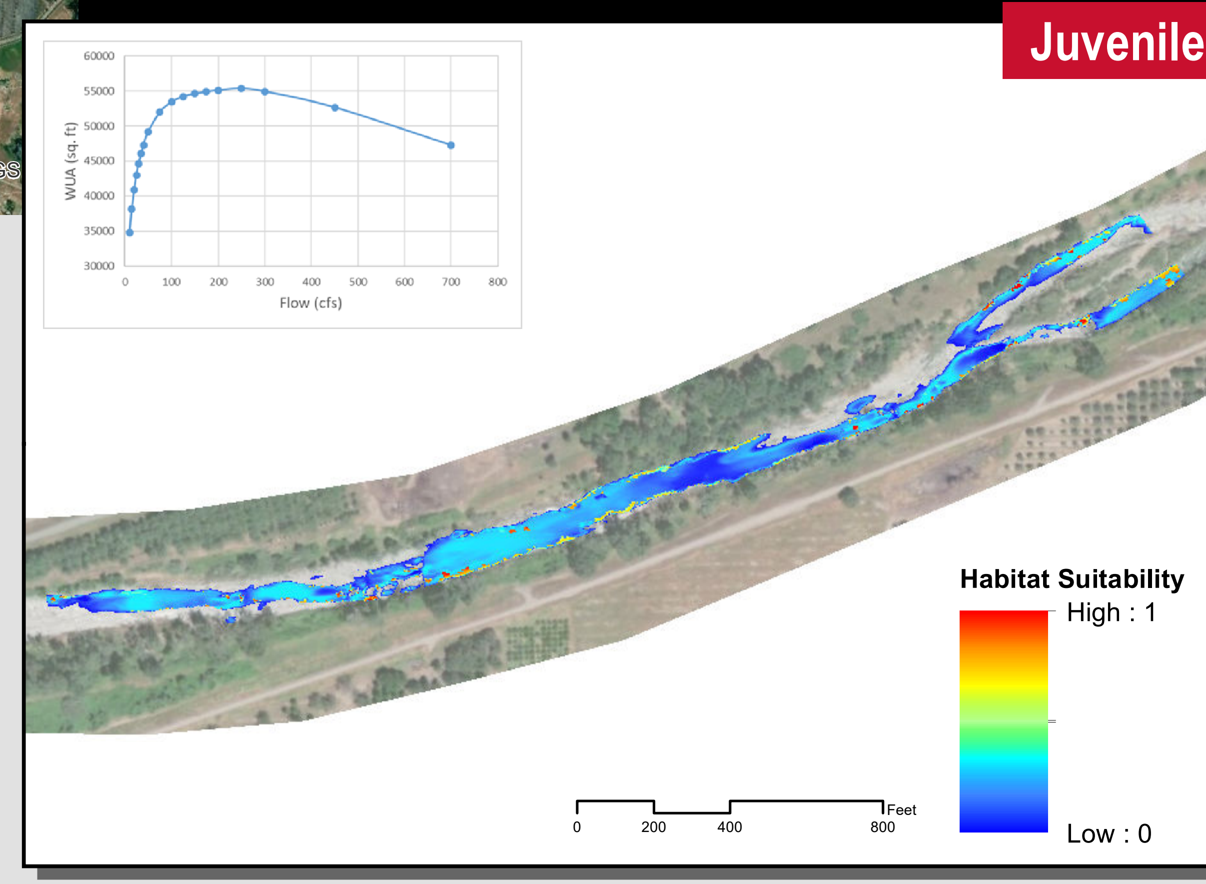
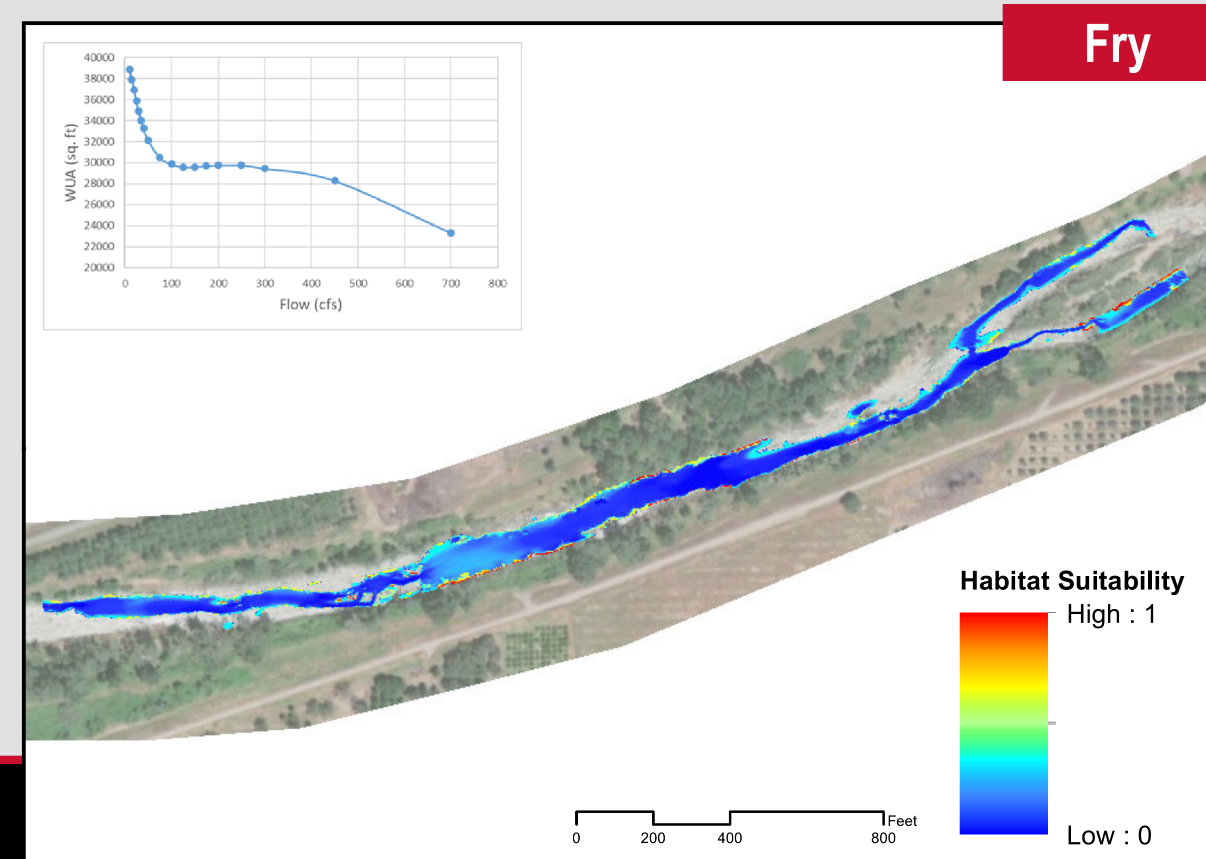
Lower Bear River - Instream Flow Study

Steelhead

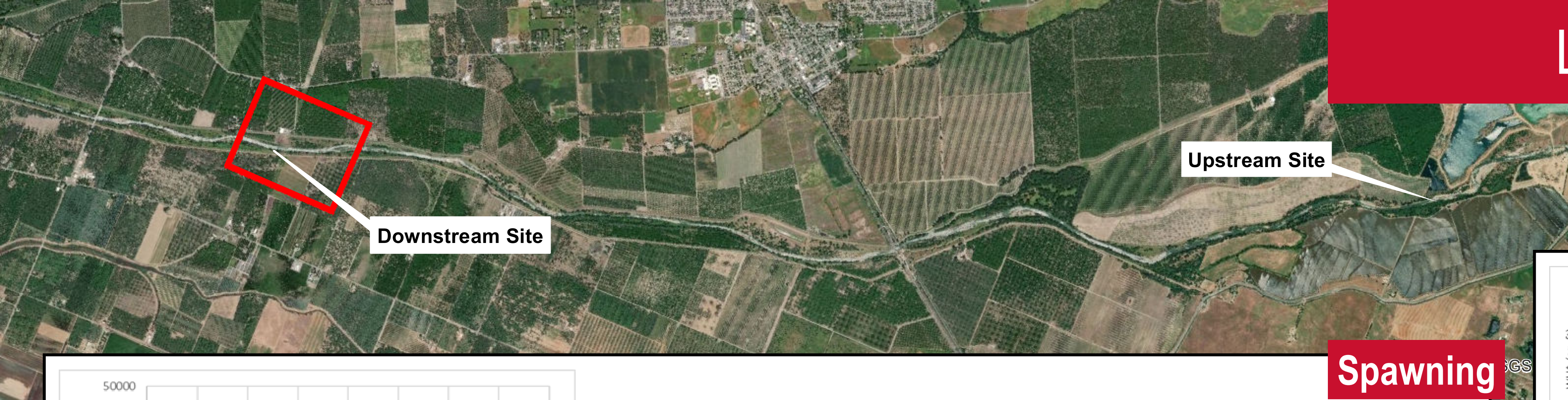
Downstream Study Site 40 cfs







Lower Bear River - Instream Flow Study



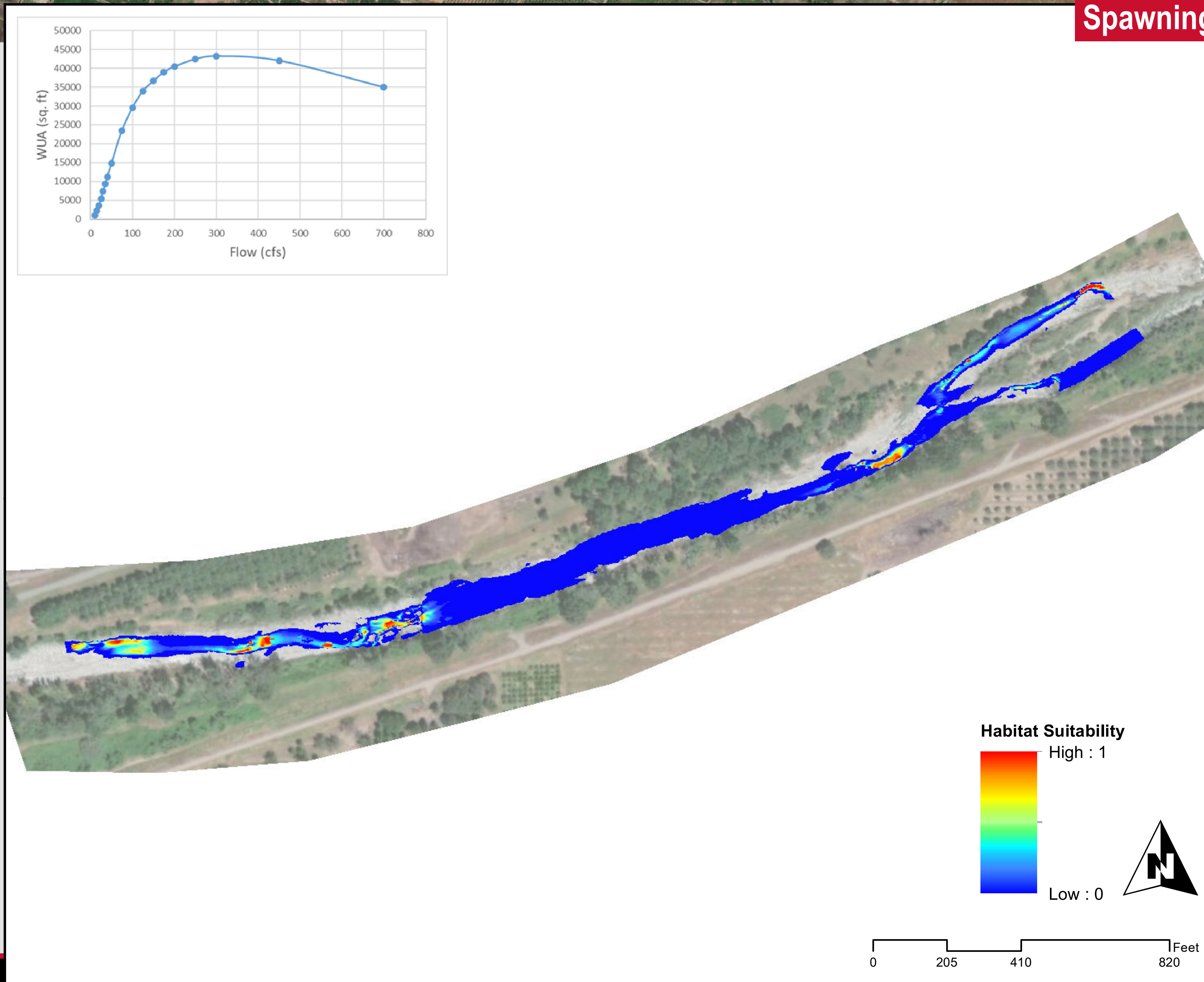
SSWD HDR

Steelhead

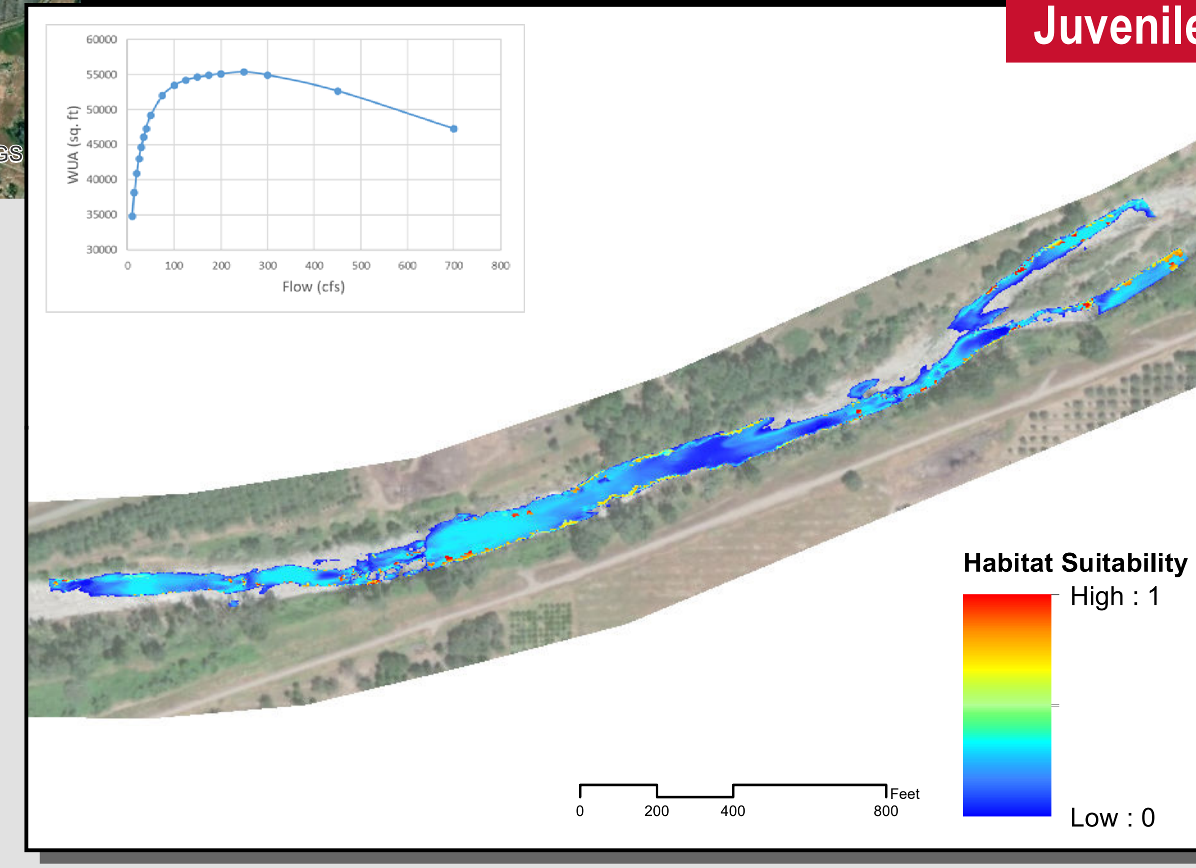
Downstream Study Site

50 cfs

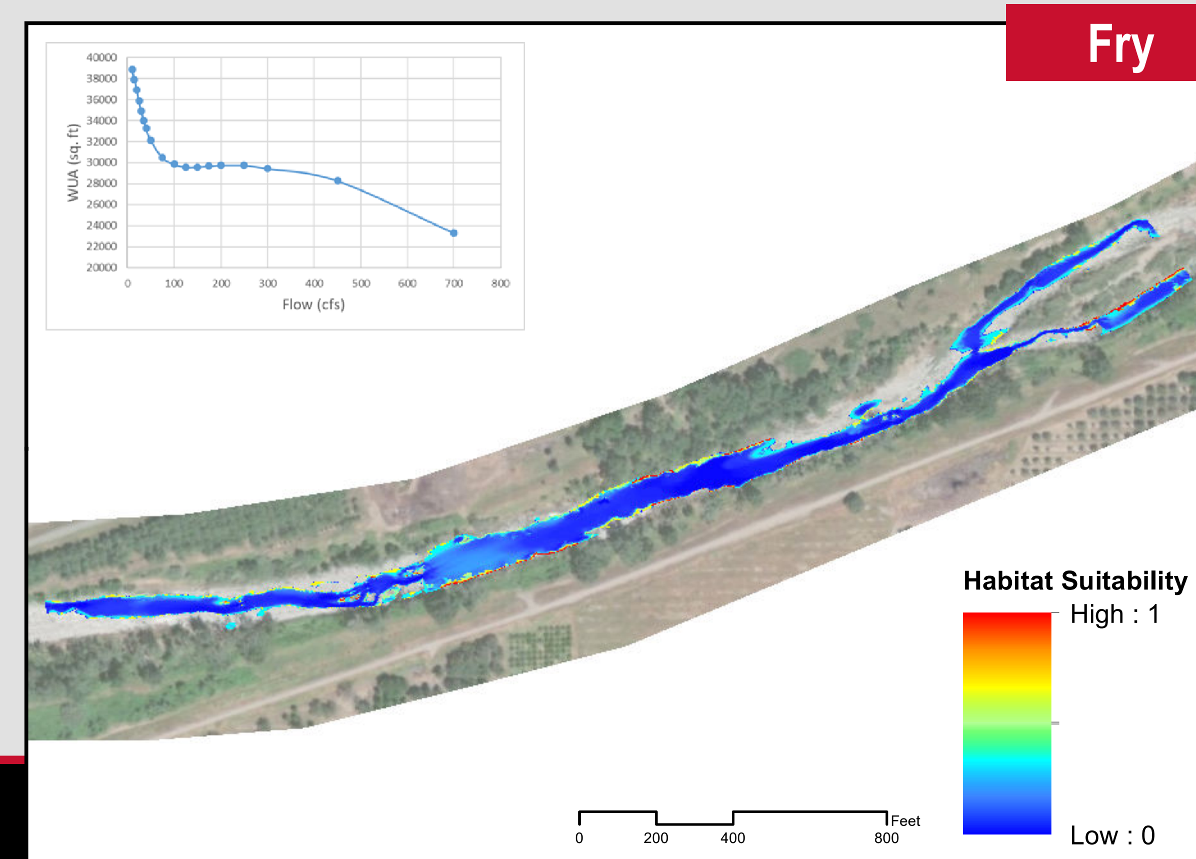
Spawning



Juvenile



Fry



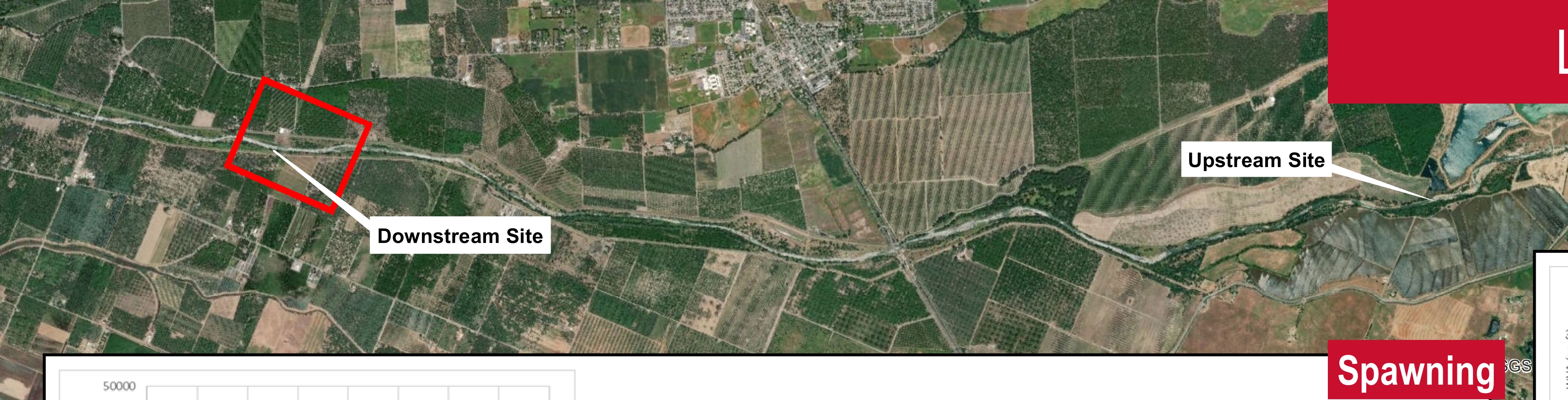
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

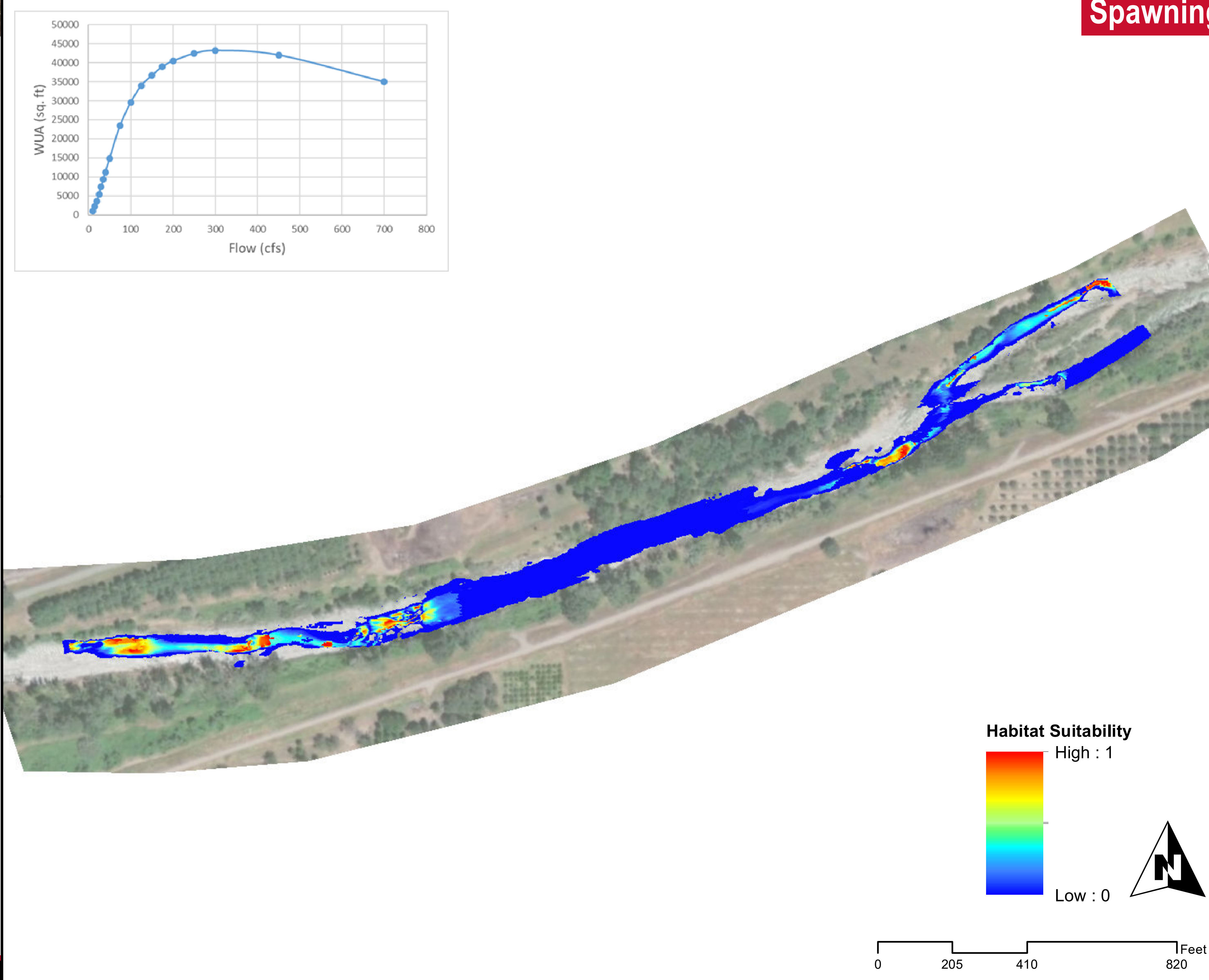
SSWD HDR

Steelhead

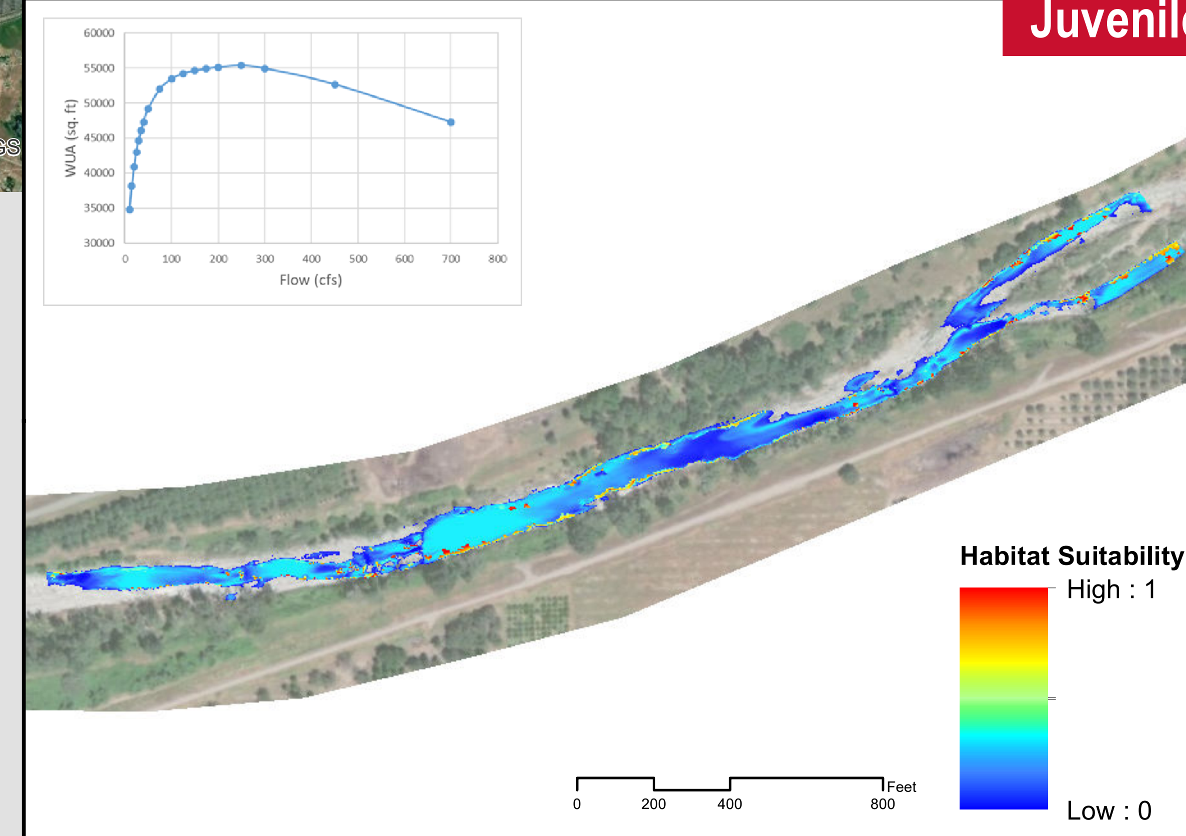
Downstream Study Site 75 cfs



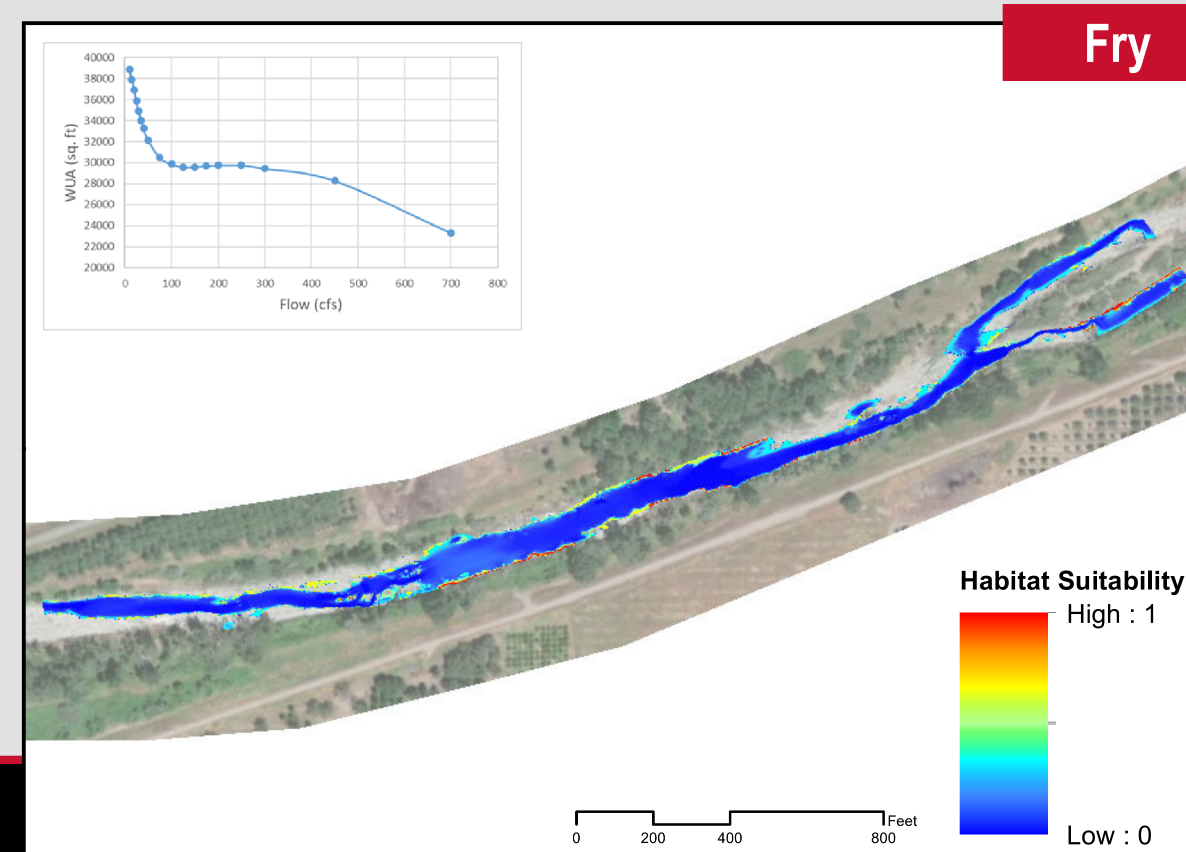
Spawning



Juvenile



Fry



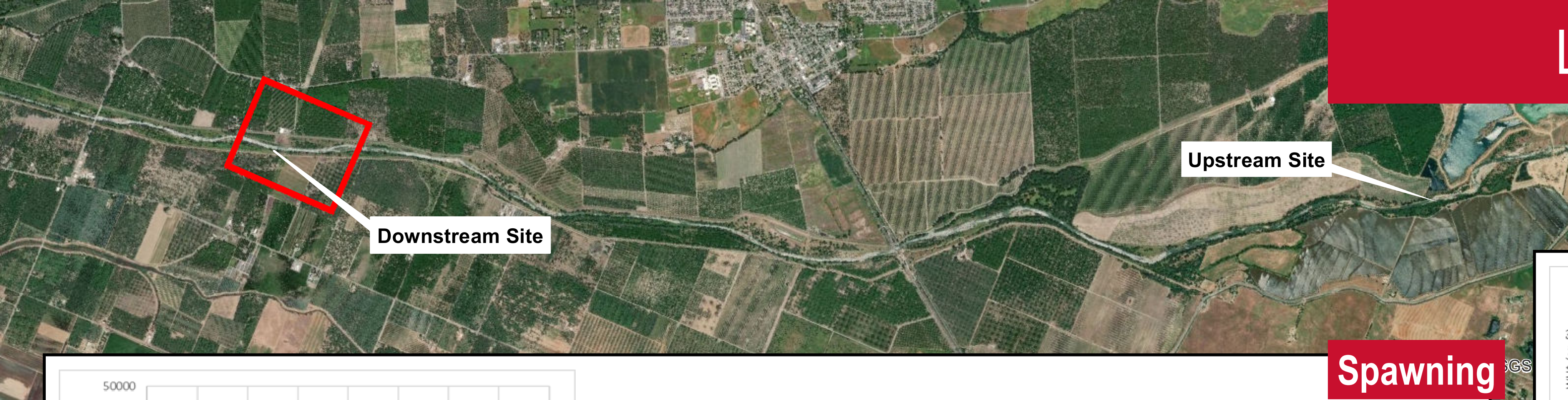
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

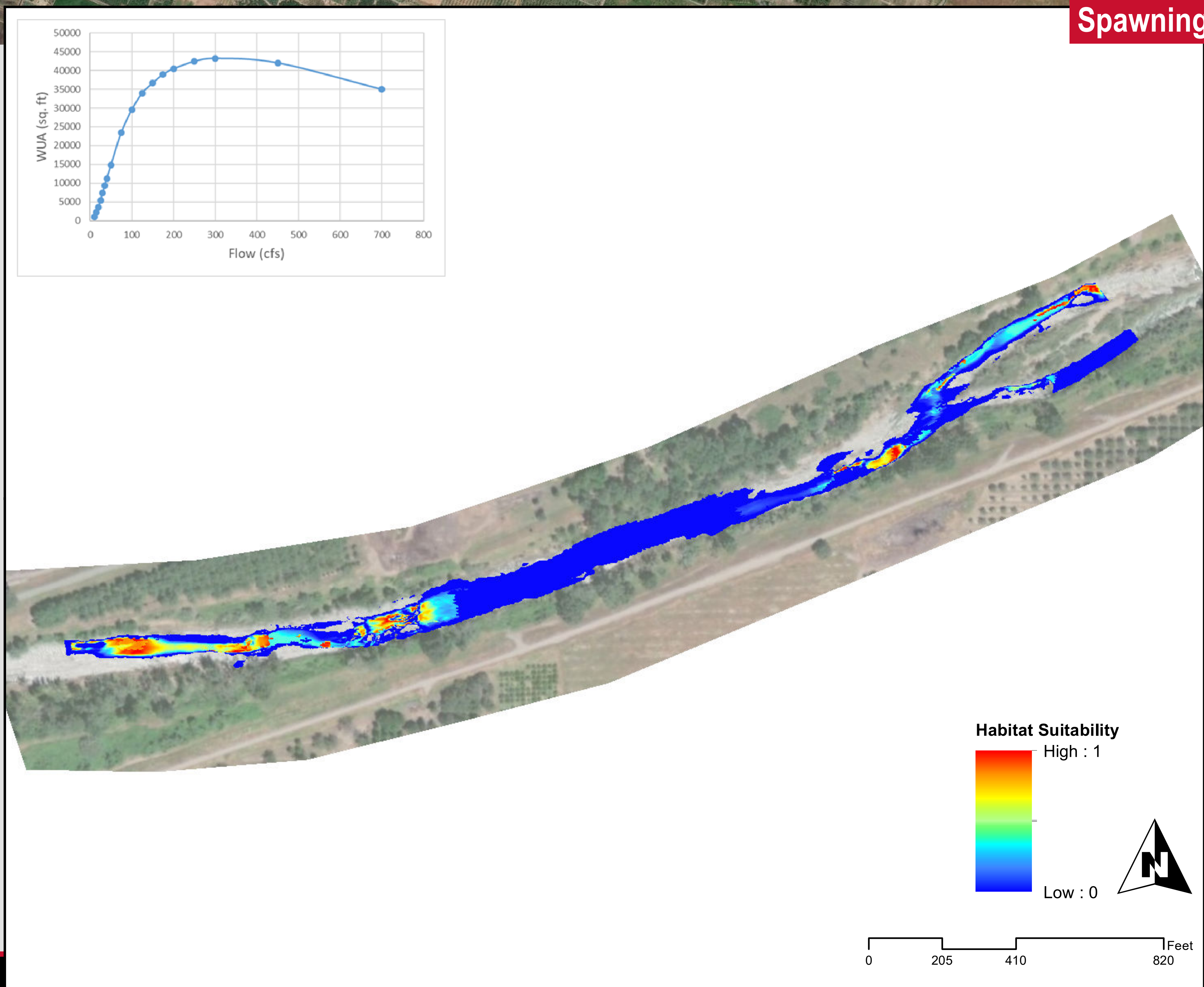
Lower Bear River - Instream Flow Study

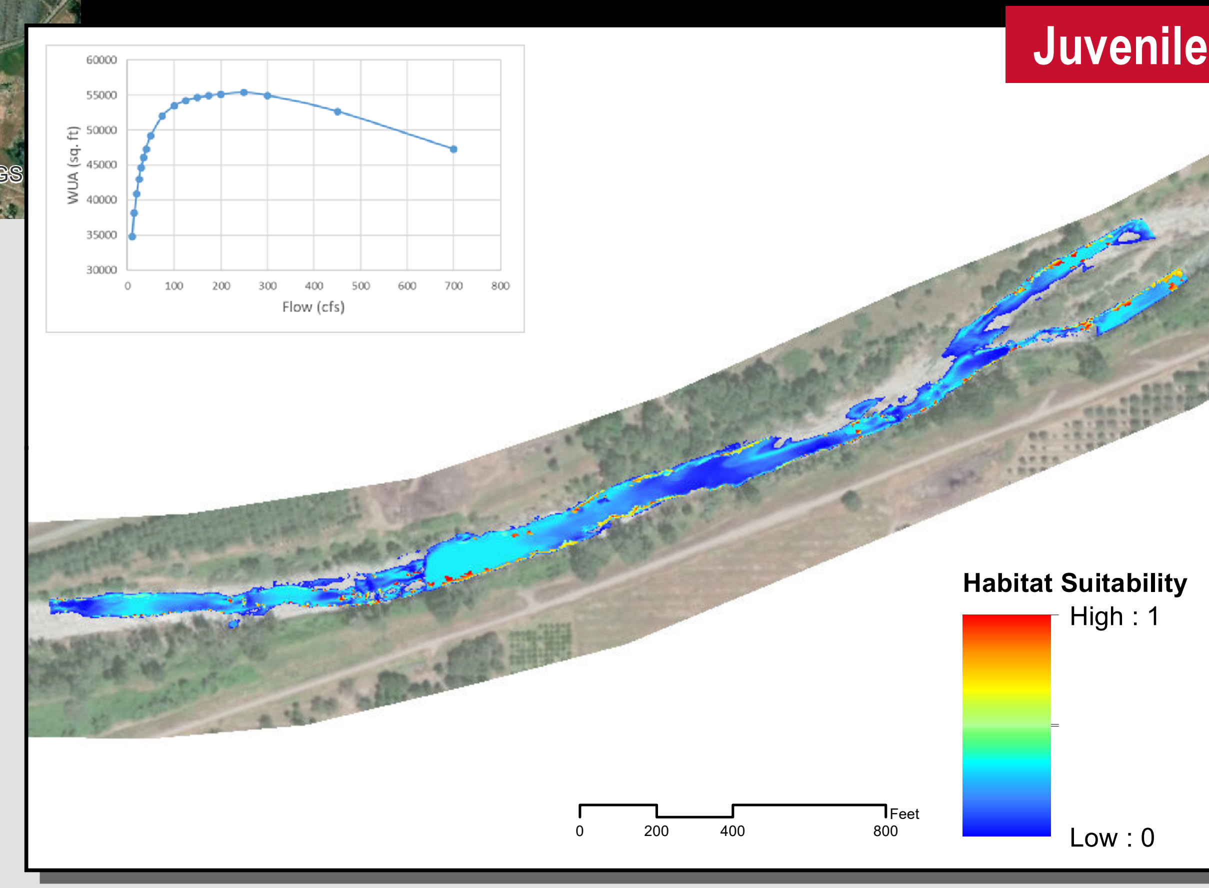
SSWD HDR

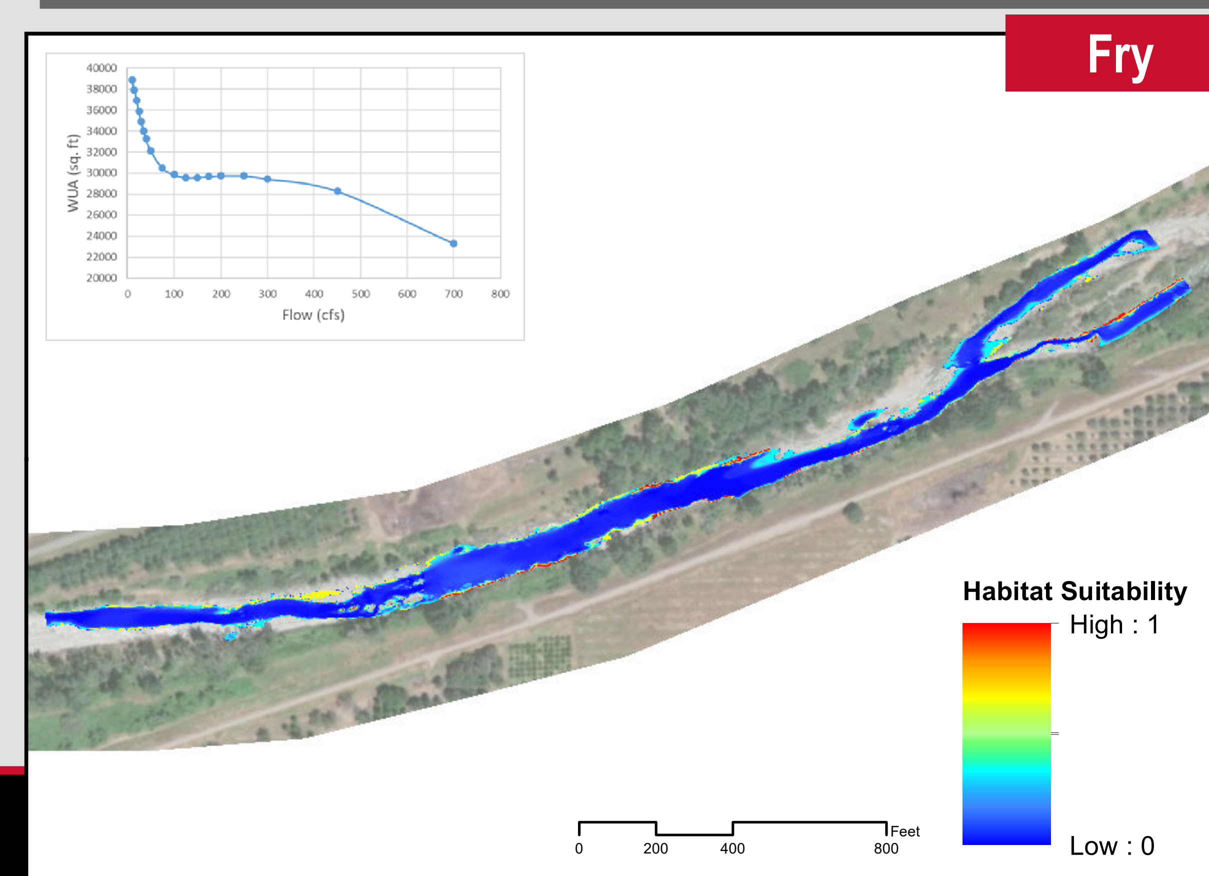
Steelhead

Downstream Study Site 100 cfs









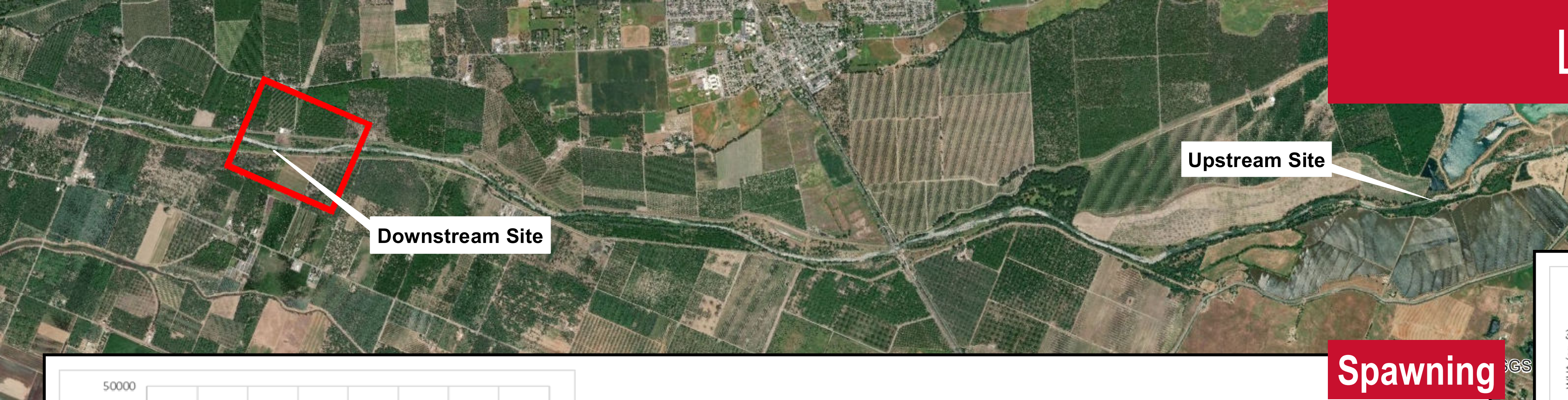
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

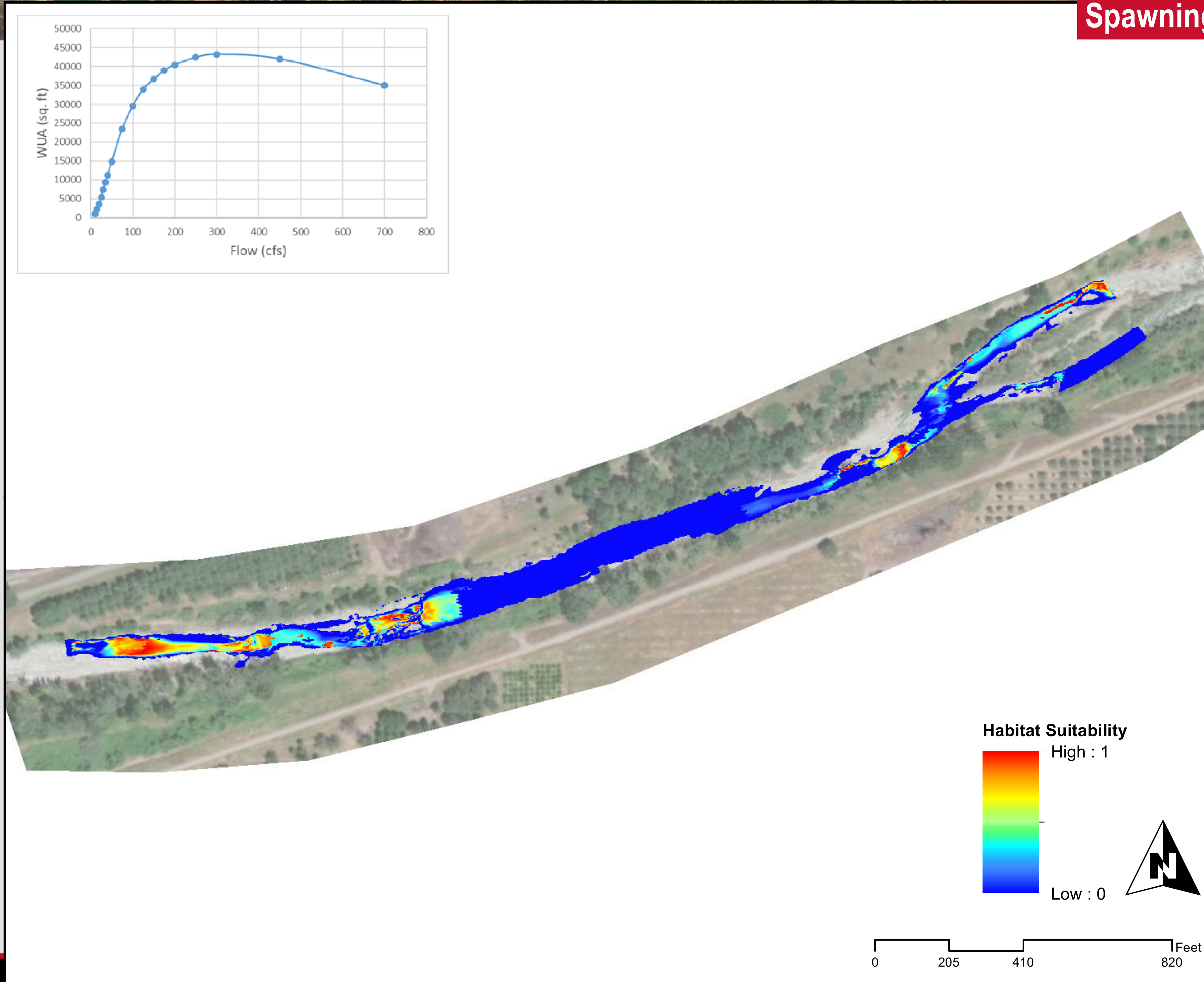
SSWD HDR

Steelhead

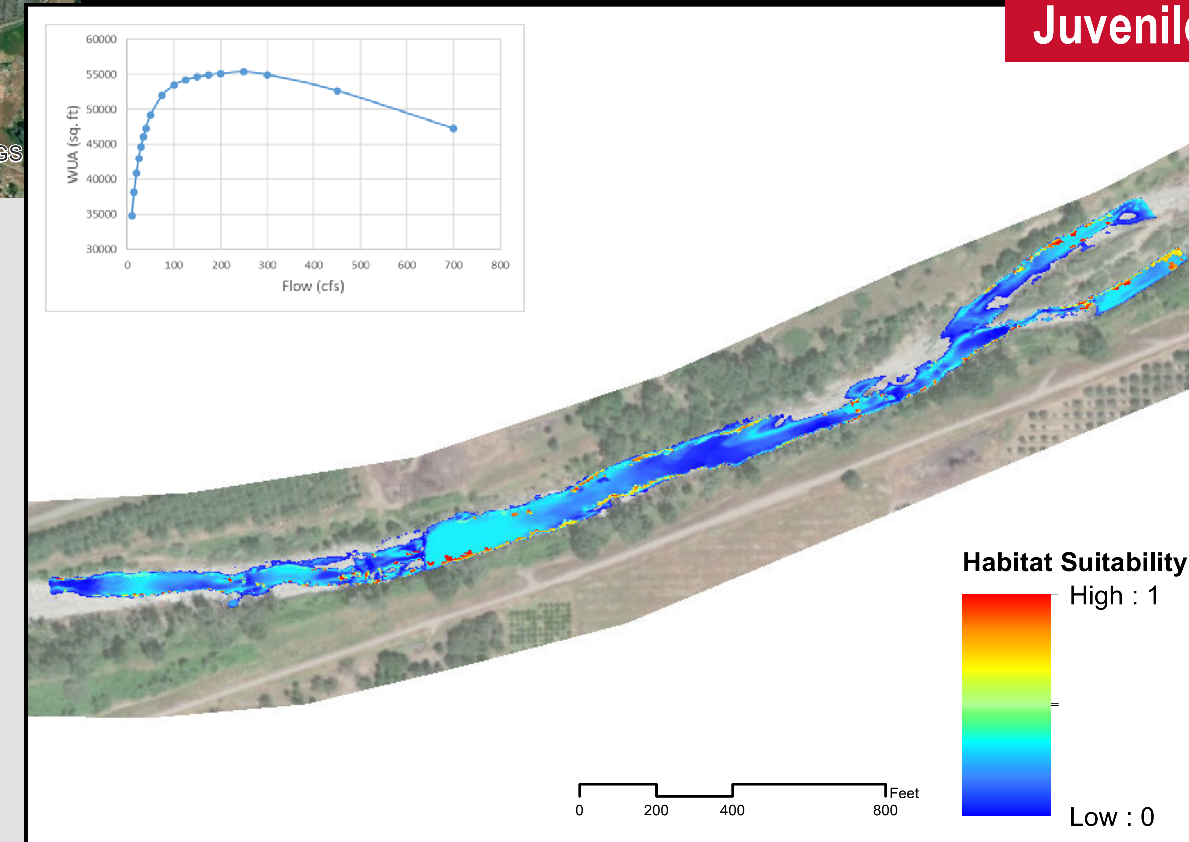
Downstream Study Site 125 cfs



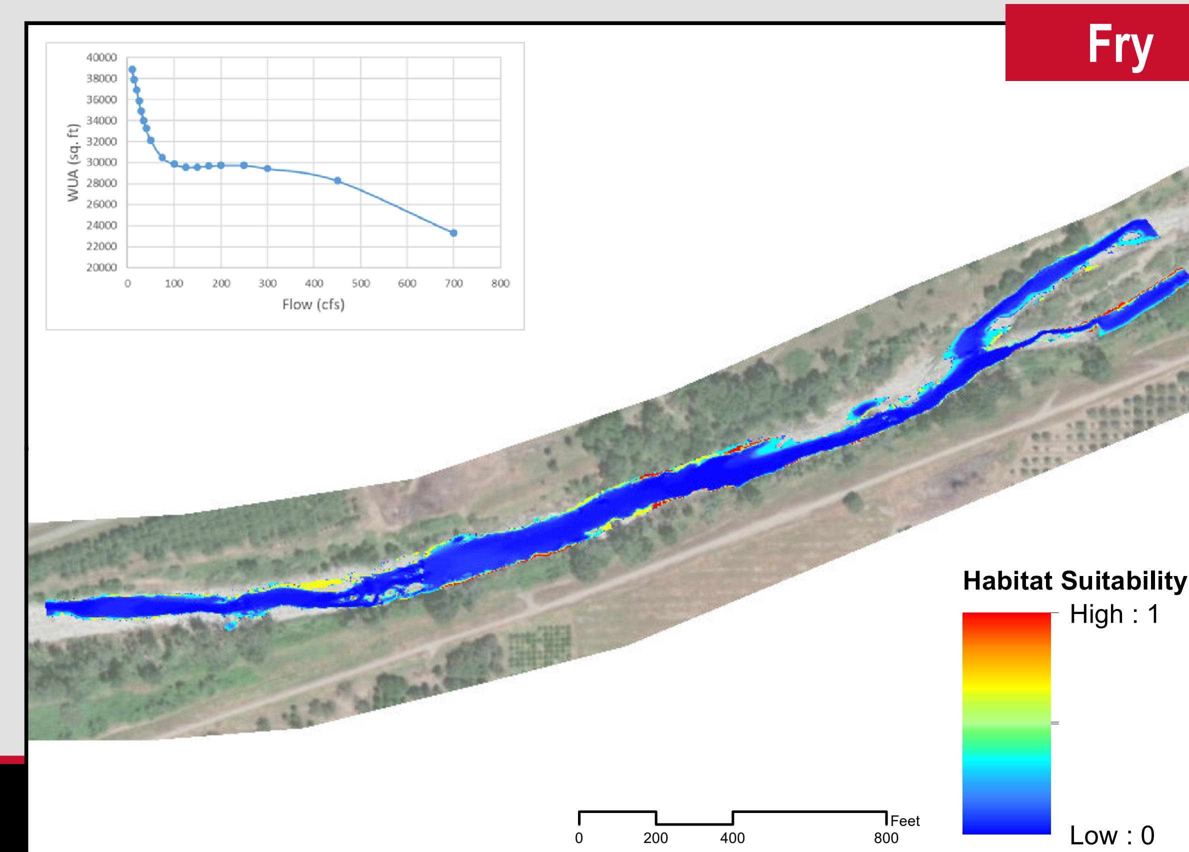
Spawning



Juvenile



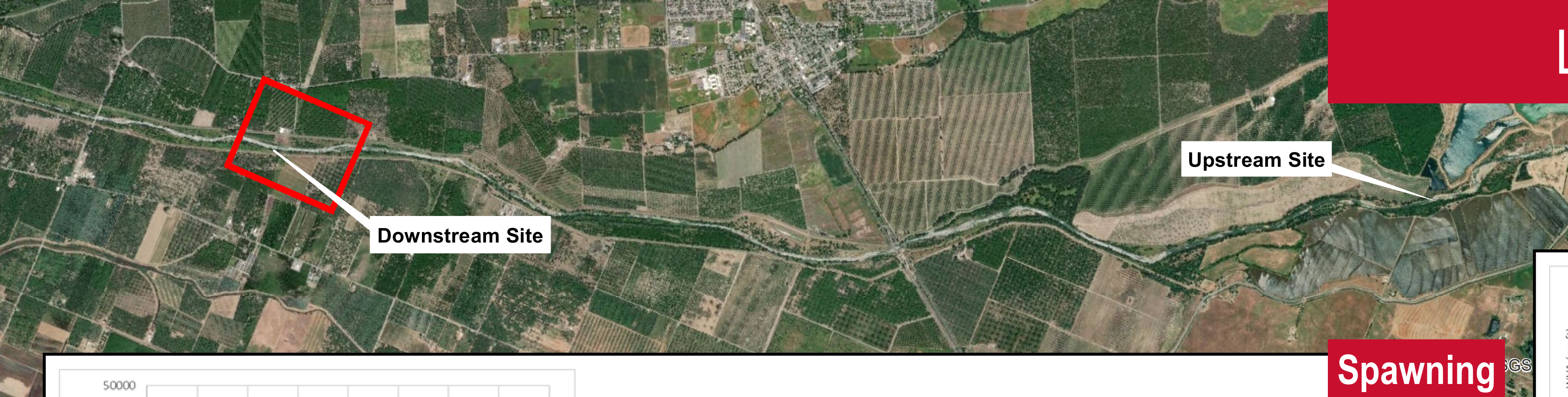
Fry



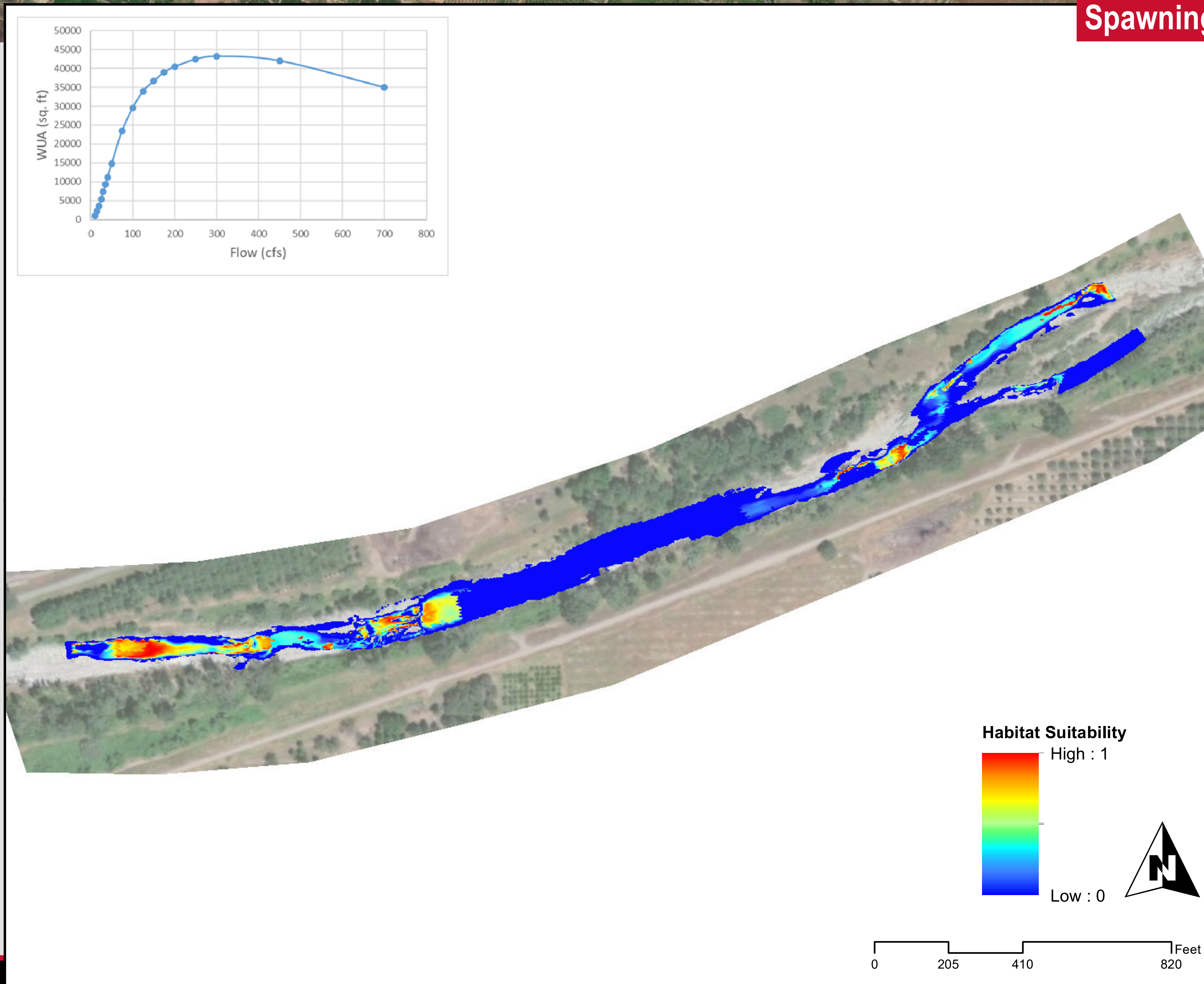
Lower Bear River - Instream Flow Study

Steelhead

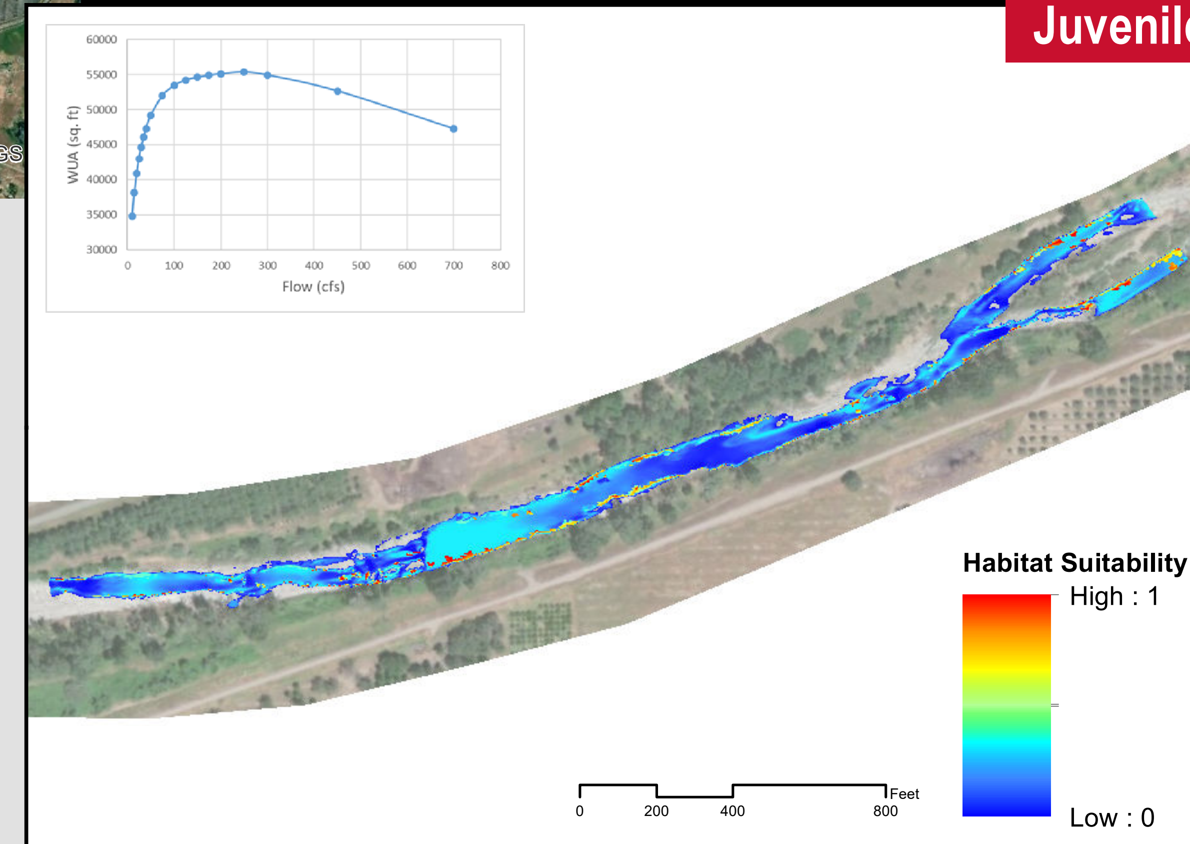
Downstream Study Site 150 cfs



Spawning



Juvenile



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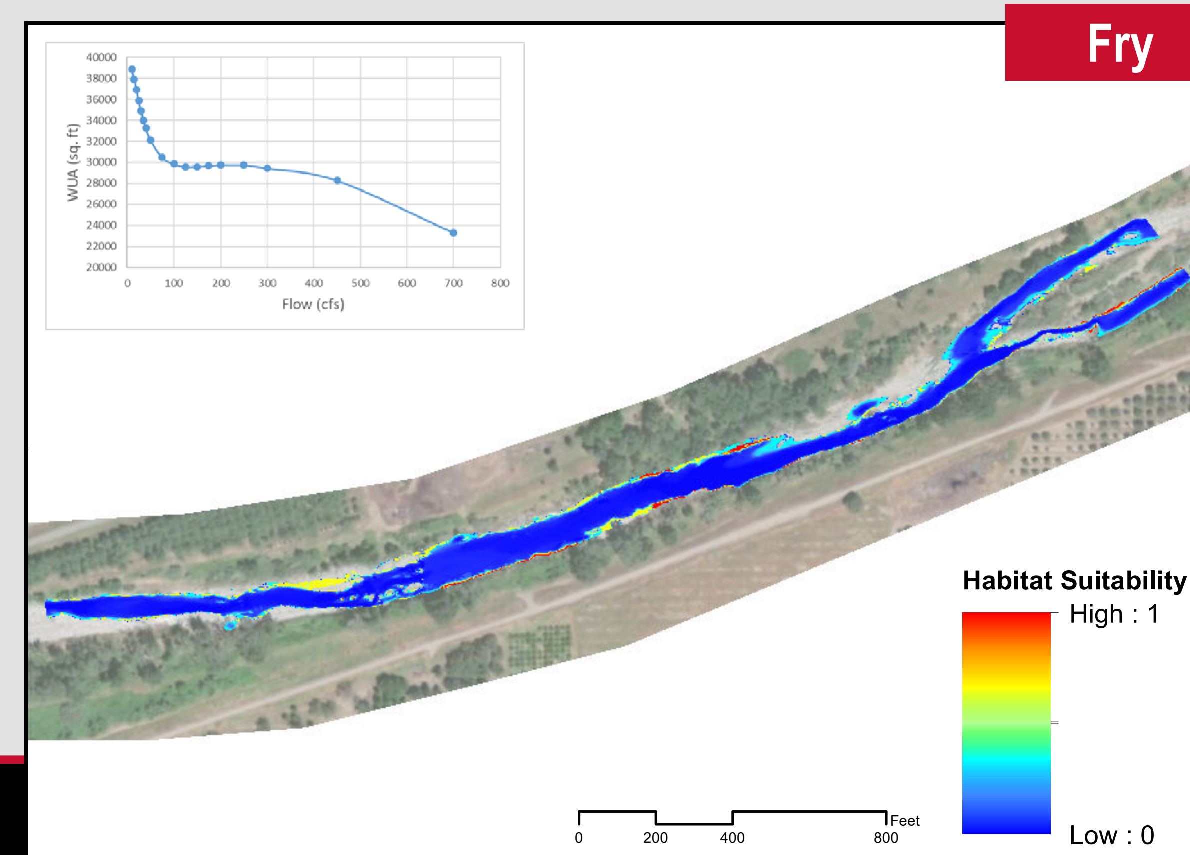
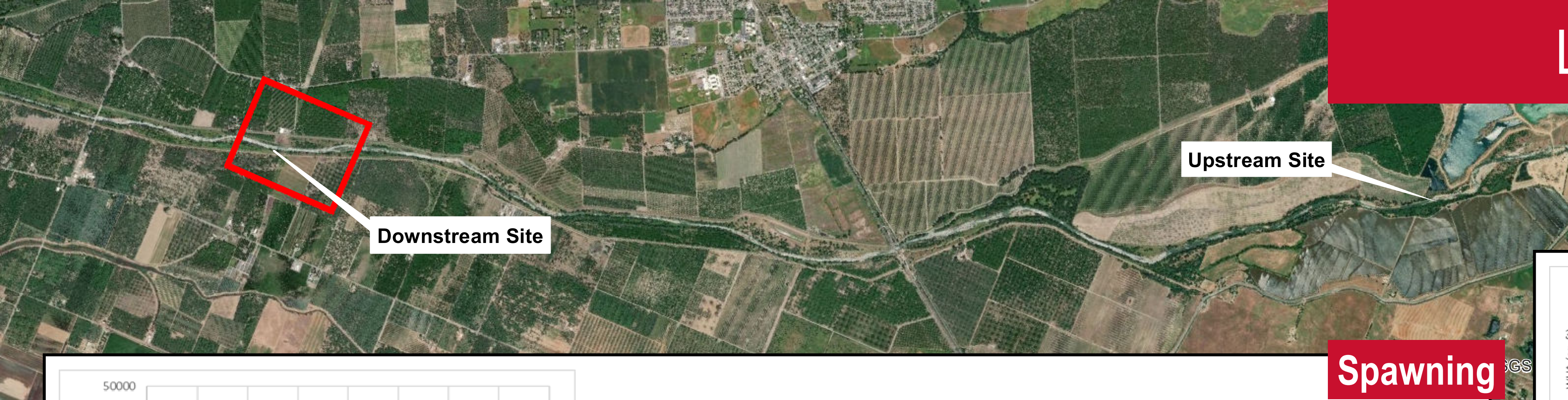


Lower Bear River - Instream Flow Study

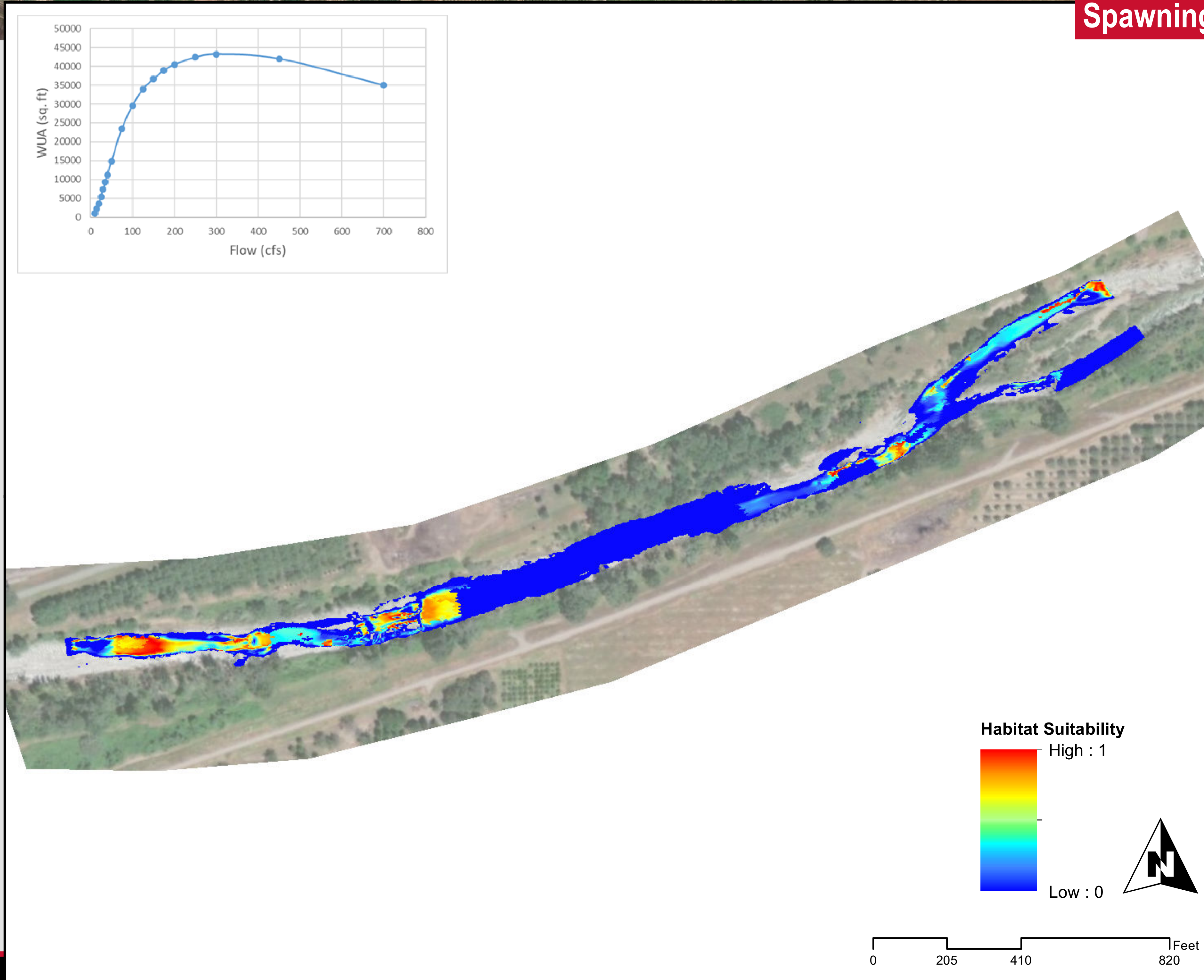
SSWD HDR

Steelhead

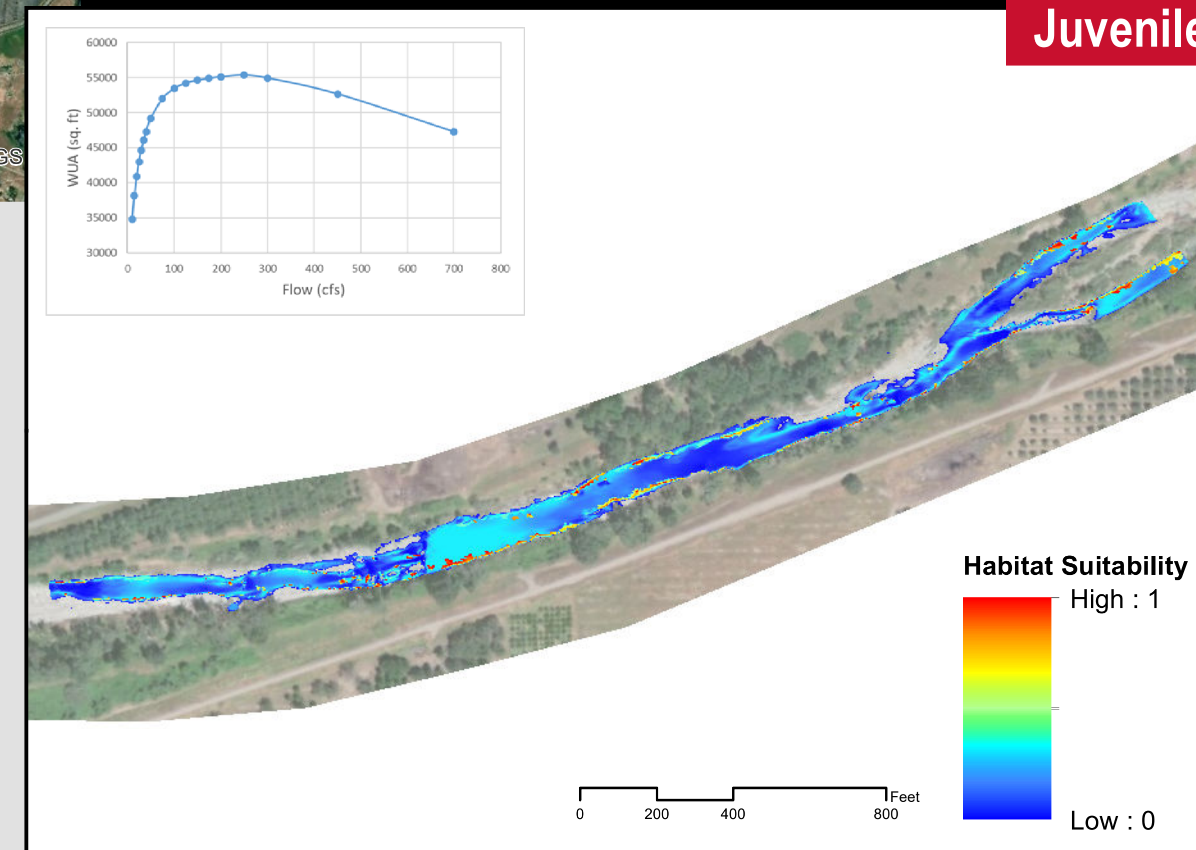
Downstream Study Site 175 cfs



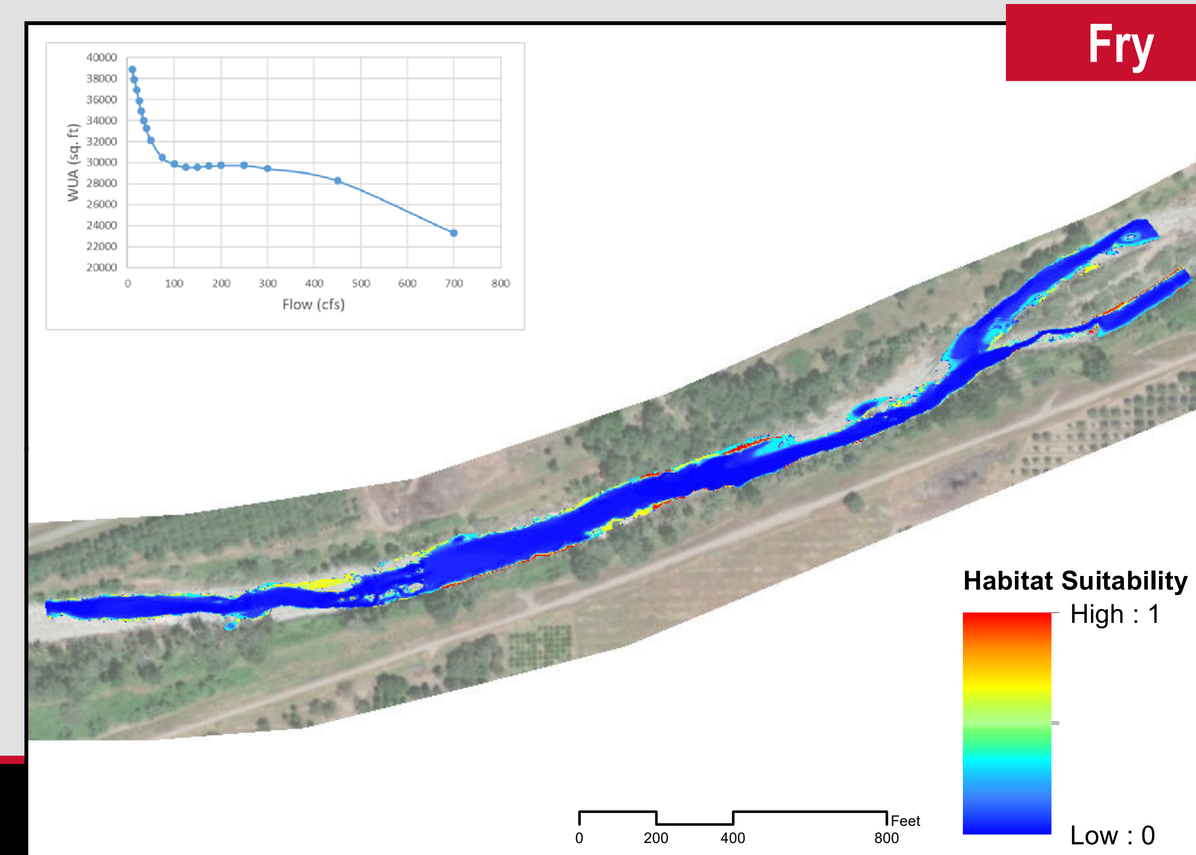
Spawning



Juvenile



Fry



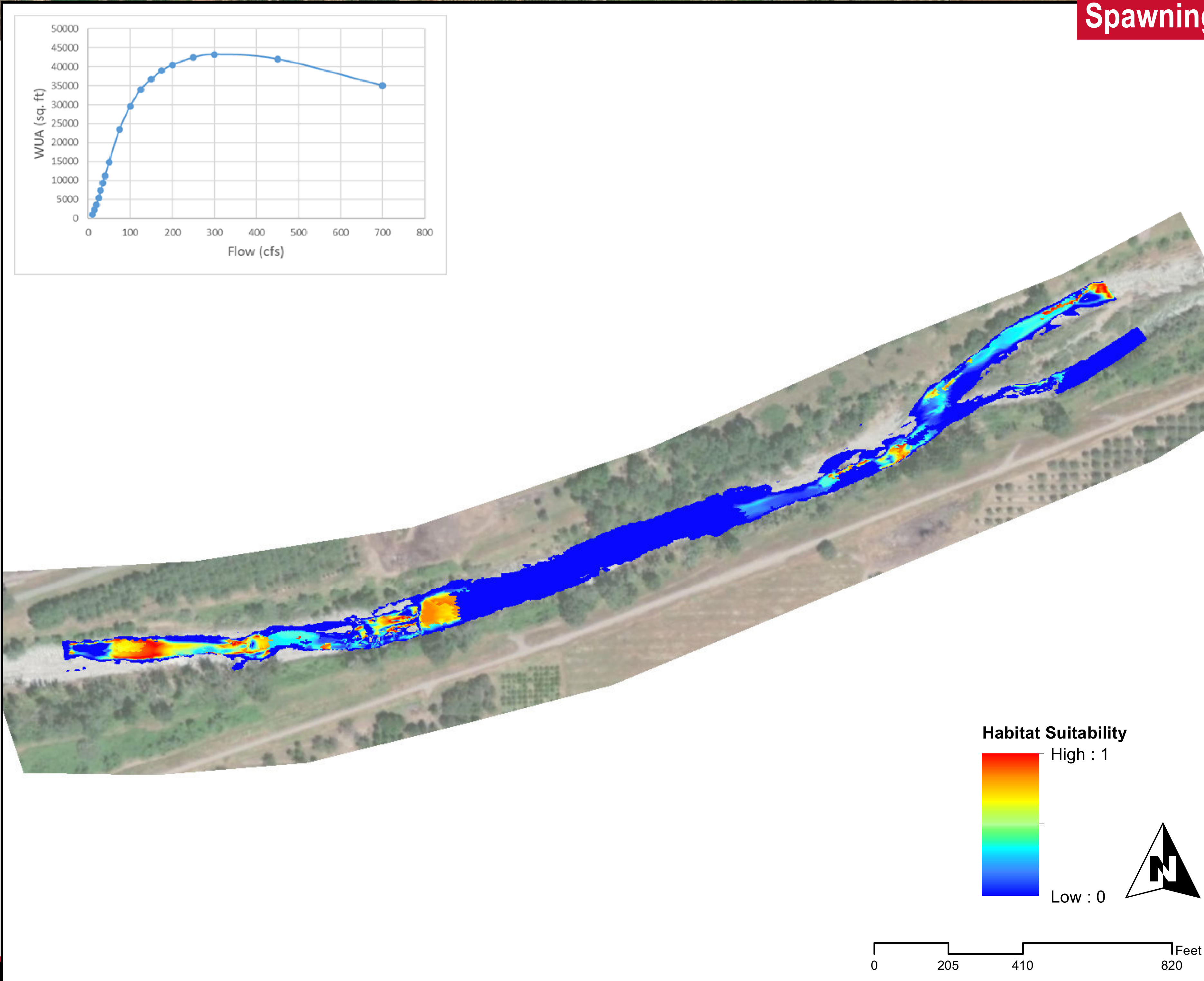
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

Lower Bear River - Instream Flow Study

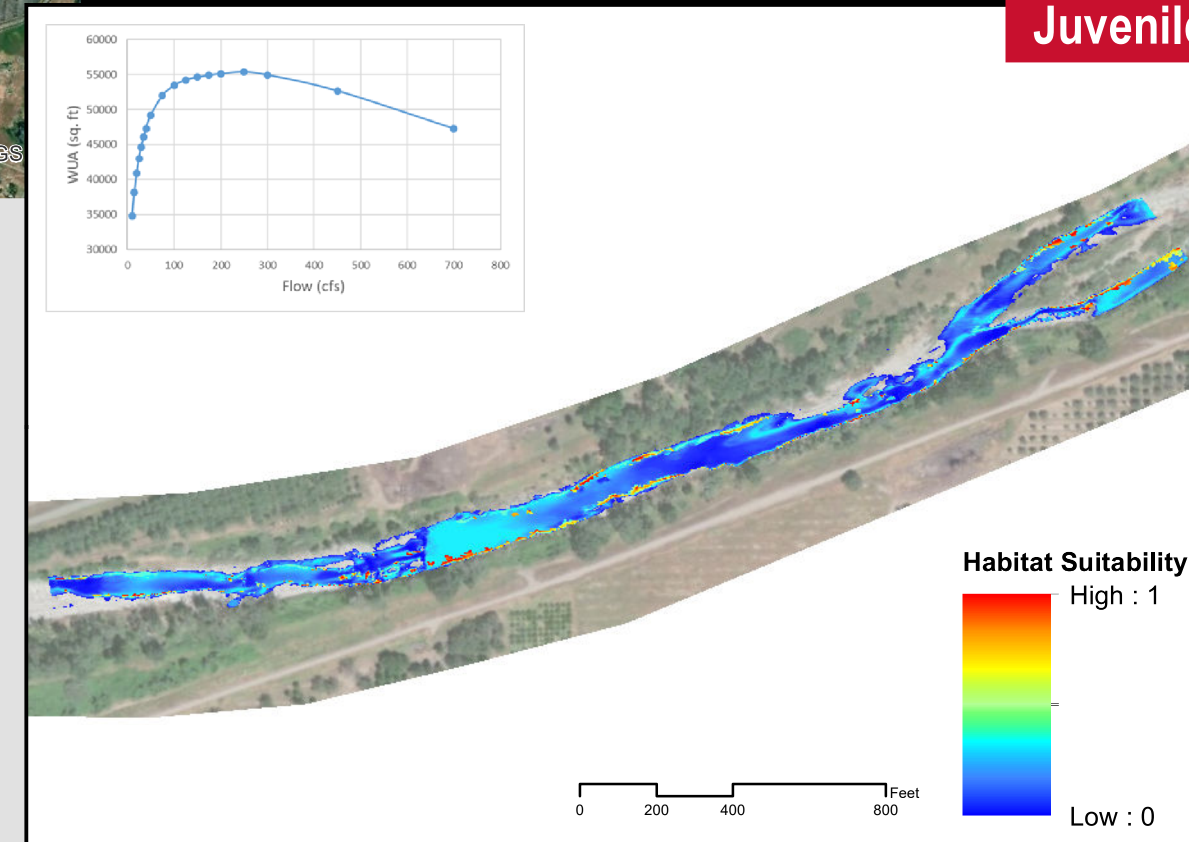
Steelhead

Downstream Study Site 200 cfs

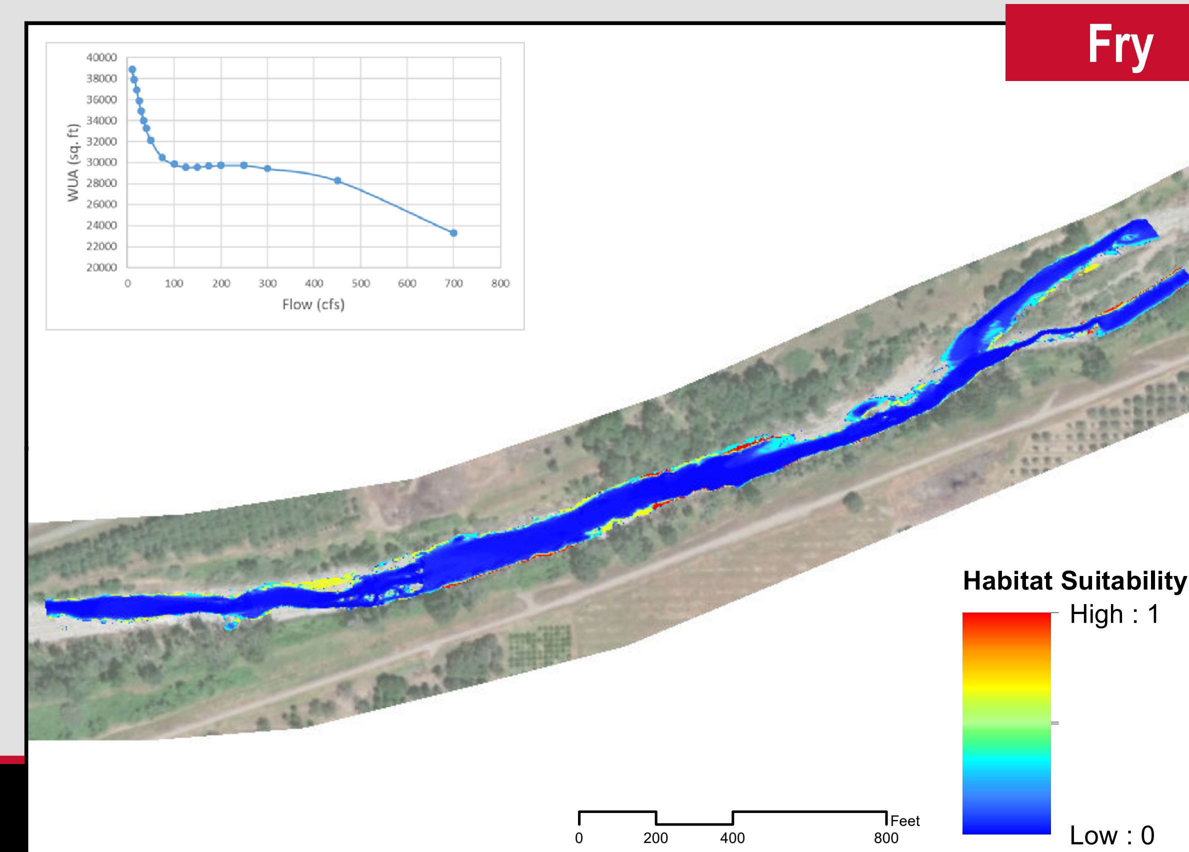
Spawning



Juvenile



Fry

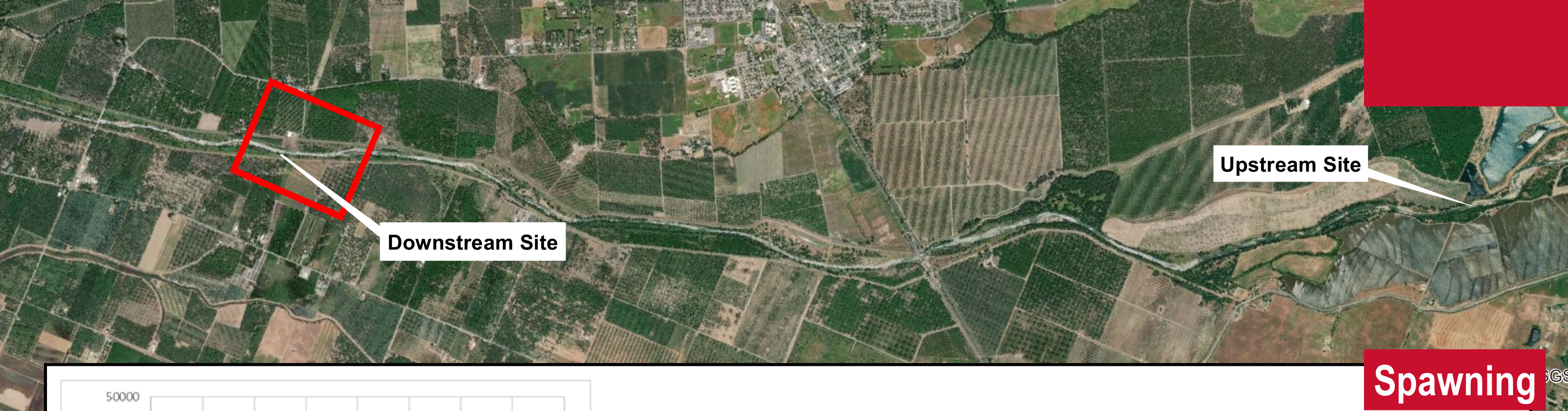


Lower Bear River - Instream Flow Study

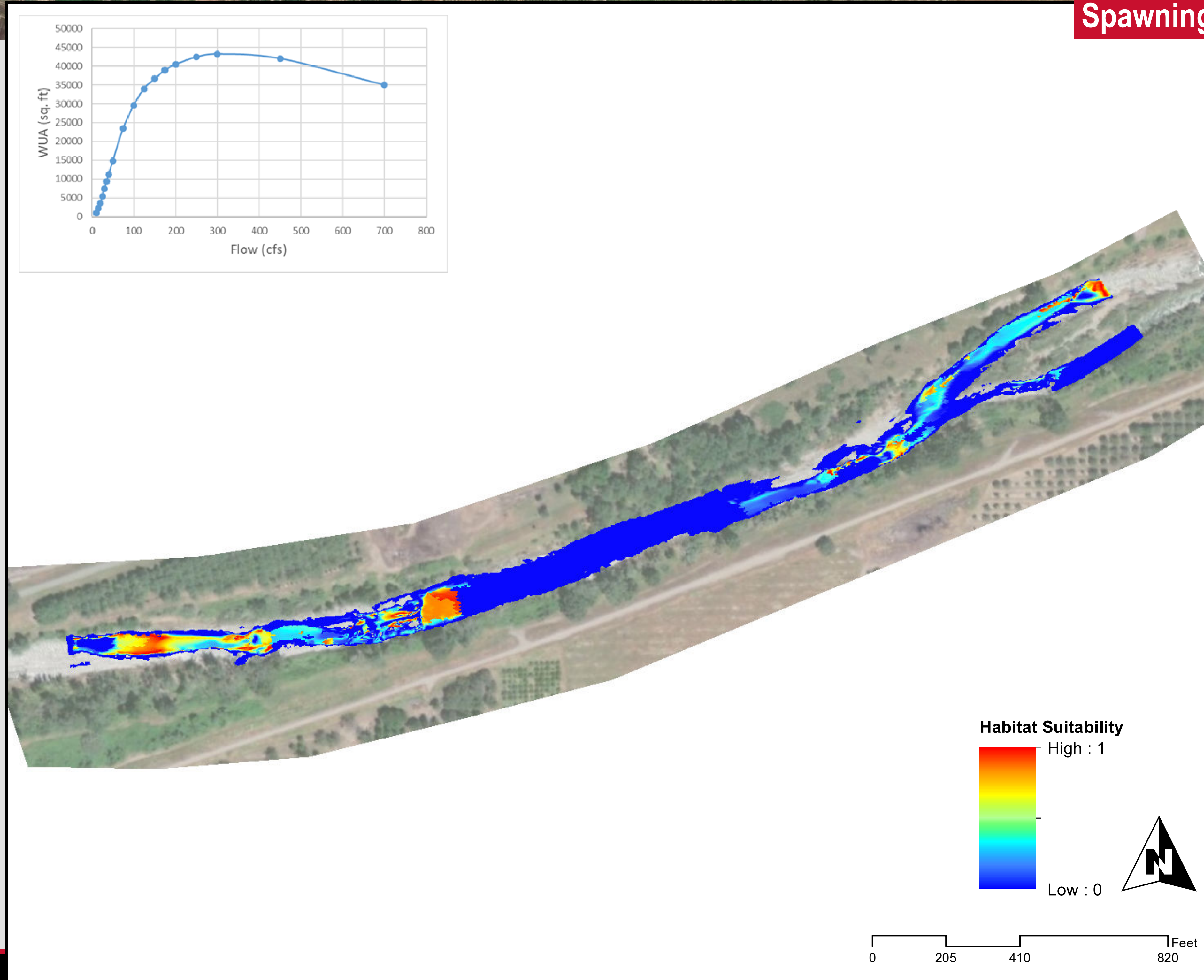
SSWD HDR

Steelhead

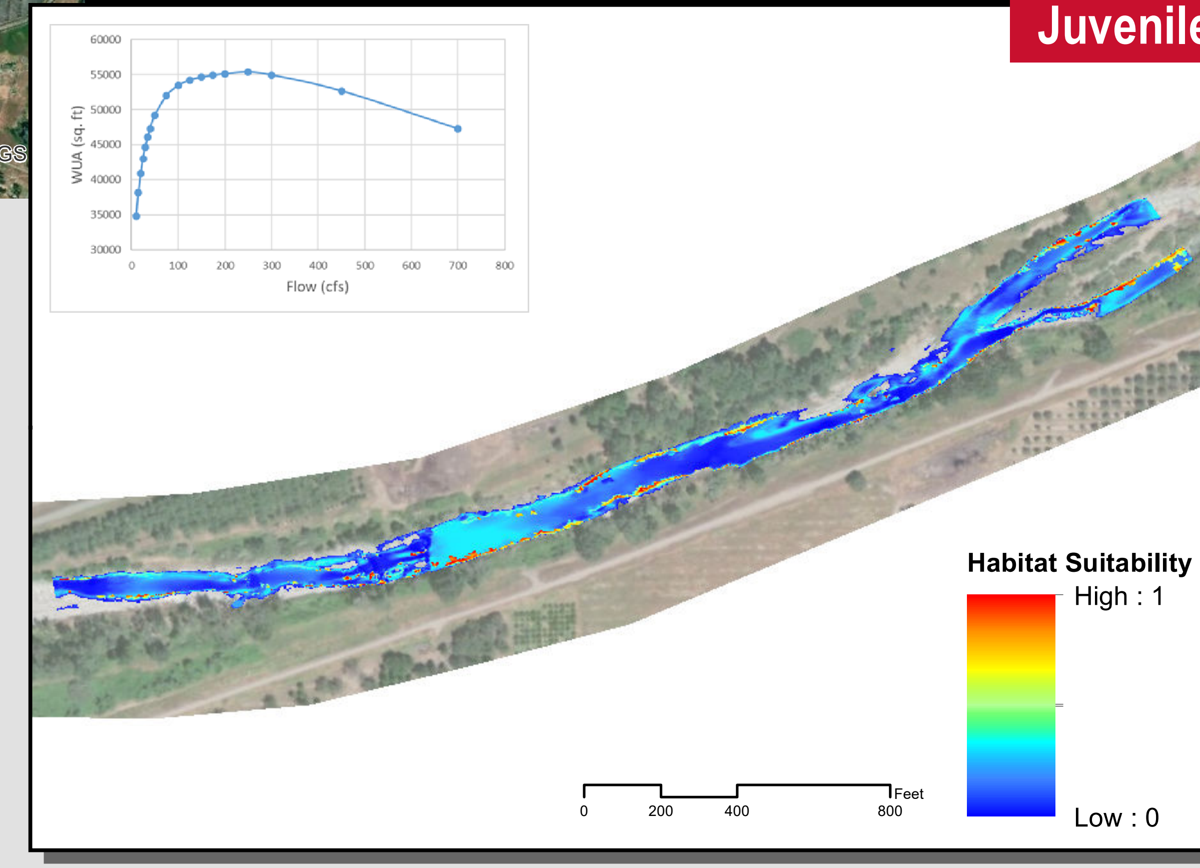
Downstream Study Site 250 cfs



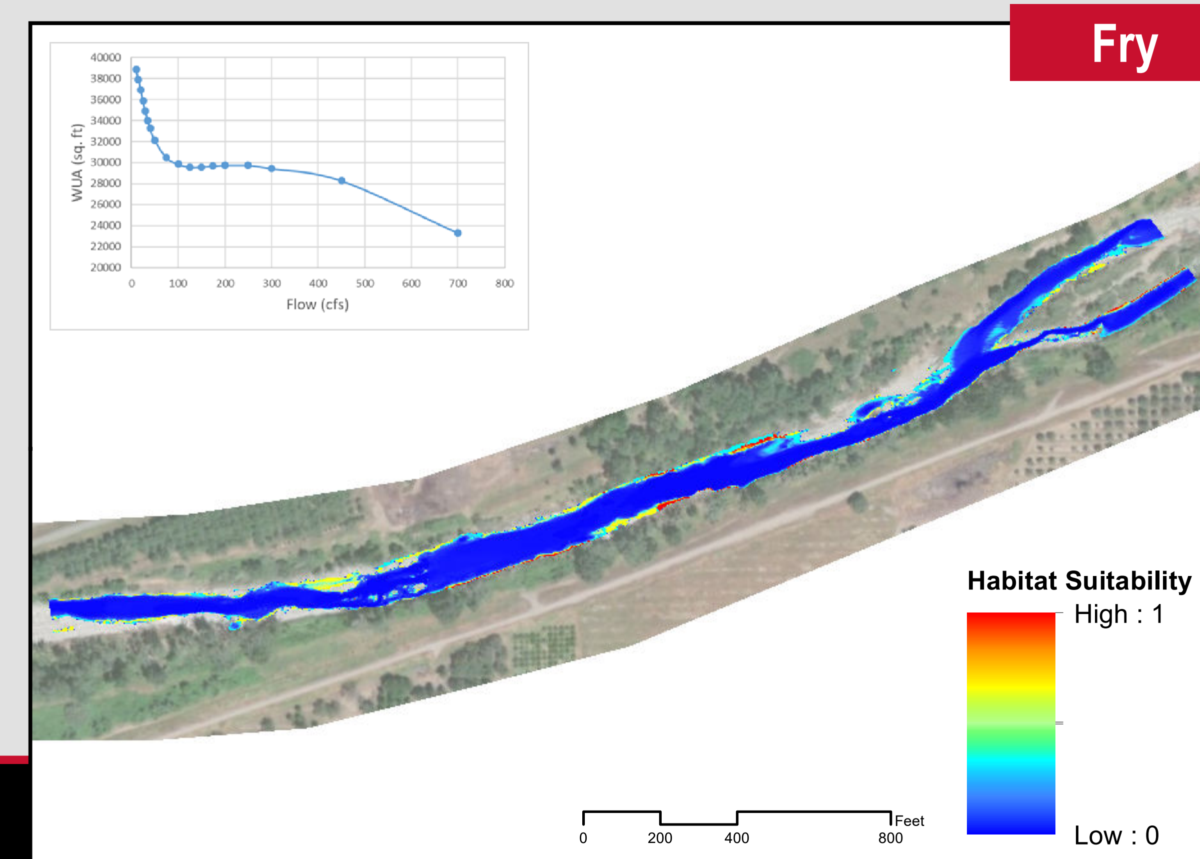
Spawning



Juvenile



Fry



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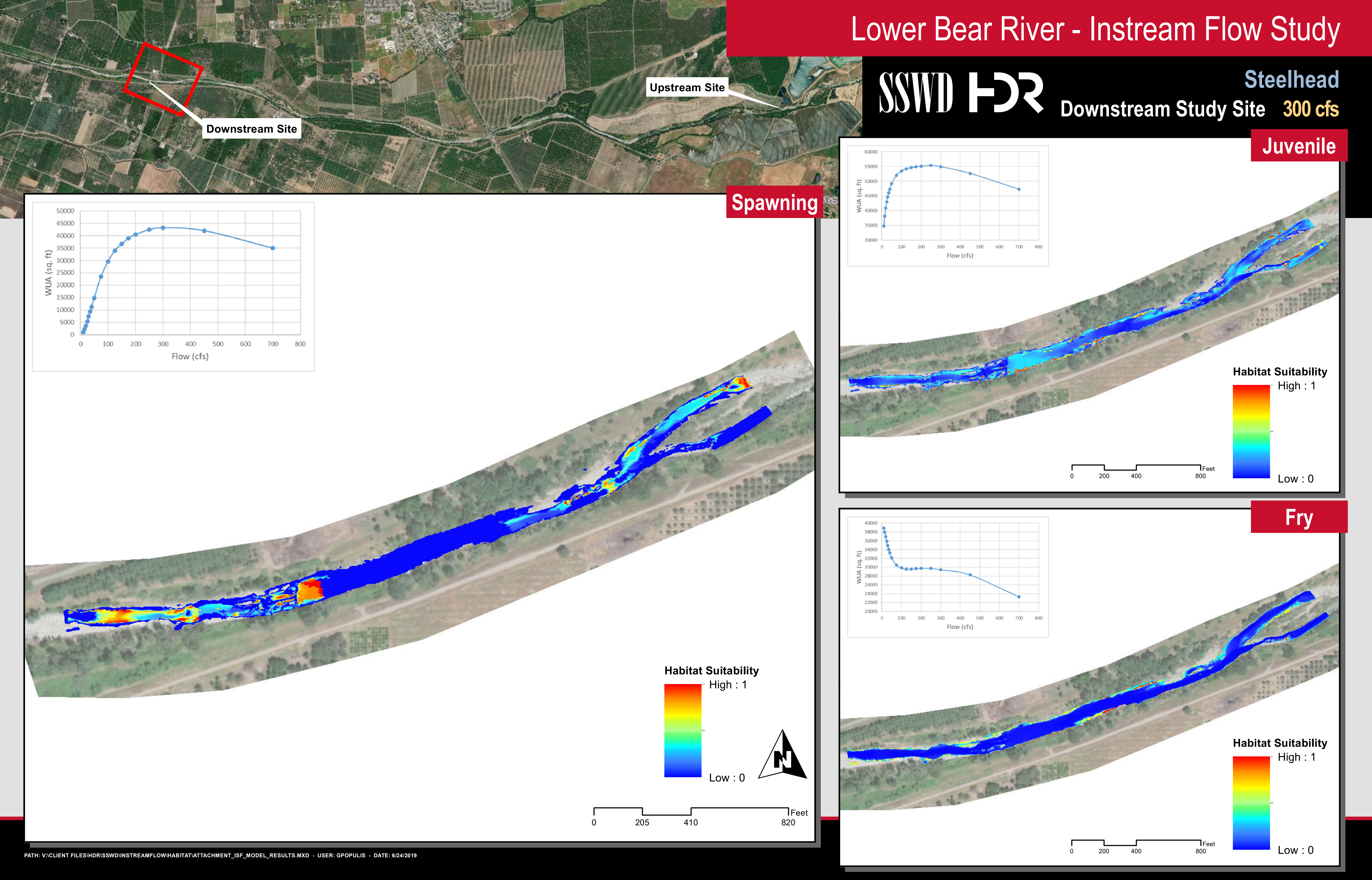
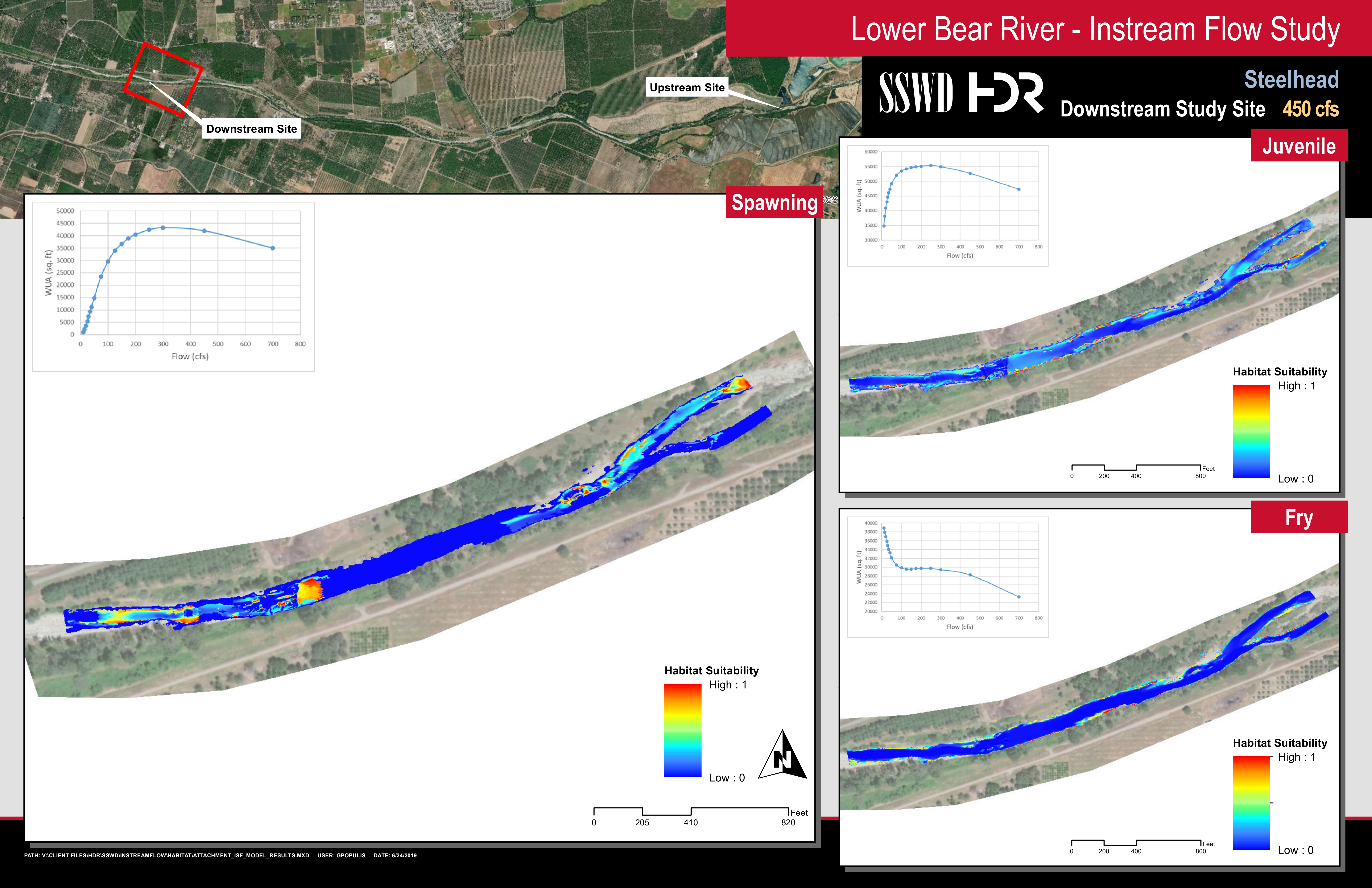


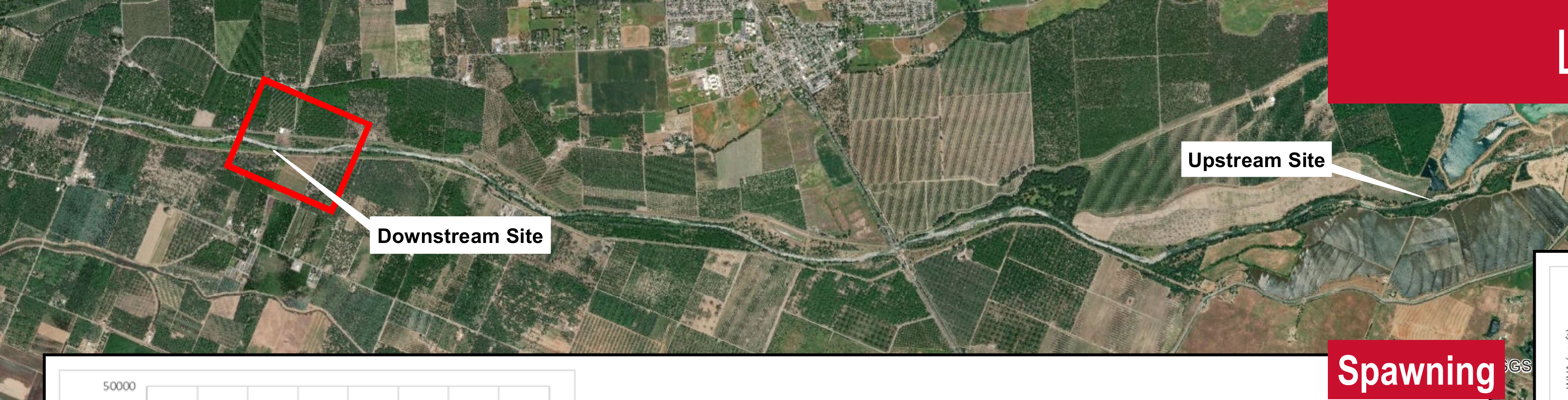
Lower Bear River - Instream Flow Study
SSWD
HDR
Steelhead
Downstream Study Site
300 cfs
Upstream Site
Downstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
N
0 205 410 820 Feet
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 200 400 800 Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 200 400 800 Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019


Lower Bear River - Instream Flow Study
SSWD
HDR
Steelhead
Downstream Study Site 450 cfs
Downstream Site
Upstream Site
Spawning
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 205 410 820 Feet
N
Juvenile
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 200 400 800 Feet
Fry
WUA (sq. ft)
Flow (cfs)
Habitat Suitability
High : 1
Low : 0
0 200 400 800 Feet
PATH: V:\CLIENT FILES\HDR\SSWD\INSTREAMFLOW\HABITAT\ATTACHMENT_ISF_MODEL_RESULTS.MXD - USER: GPOPULIS - DATE: 6/24/2019

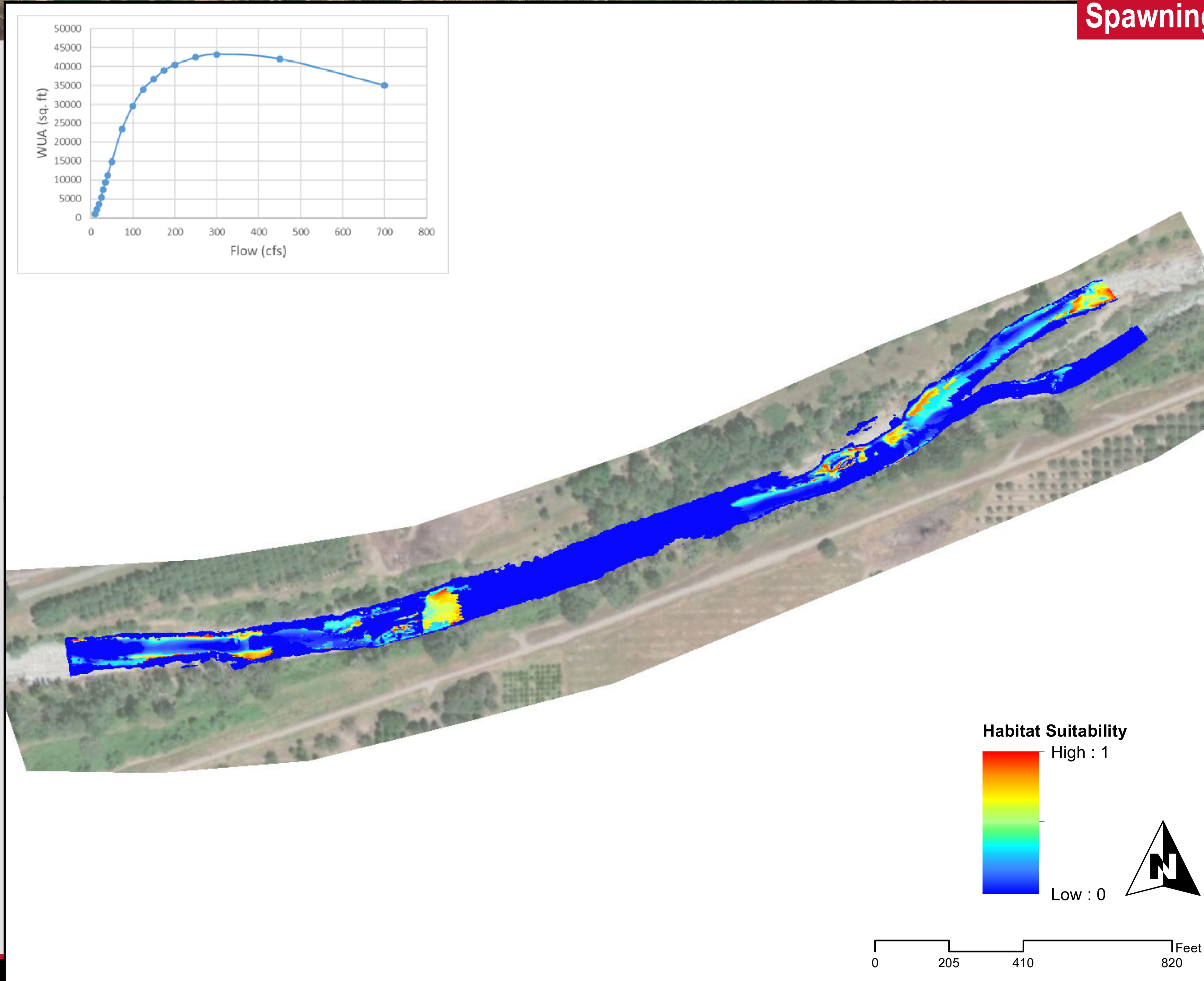
Lower Bear River - Instream Flow Study

Steelhead

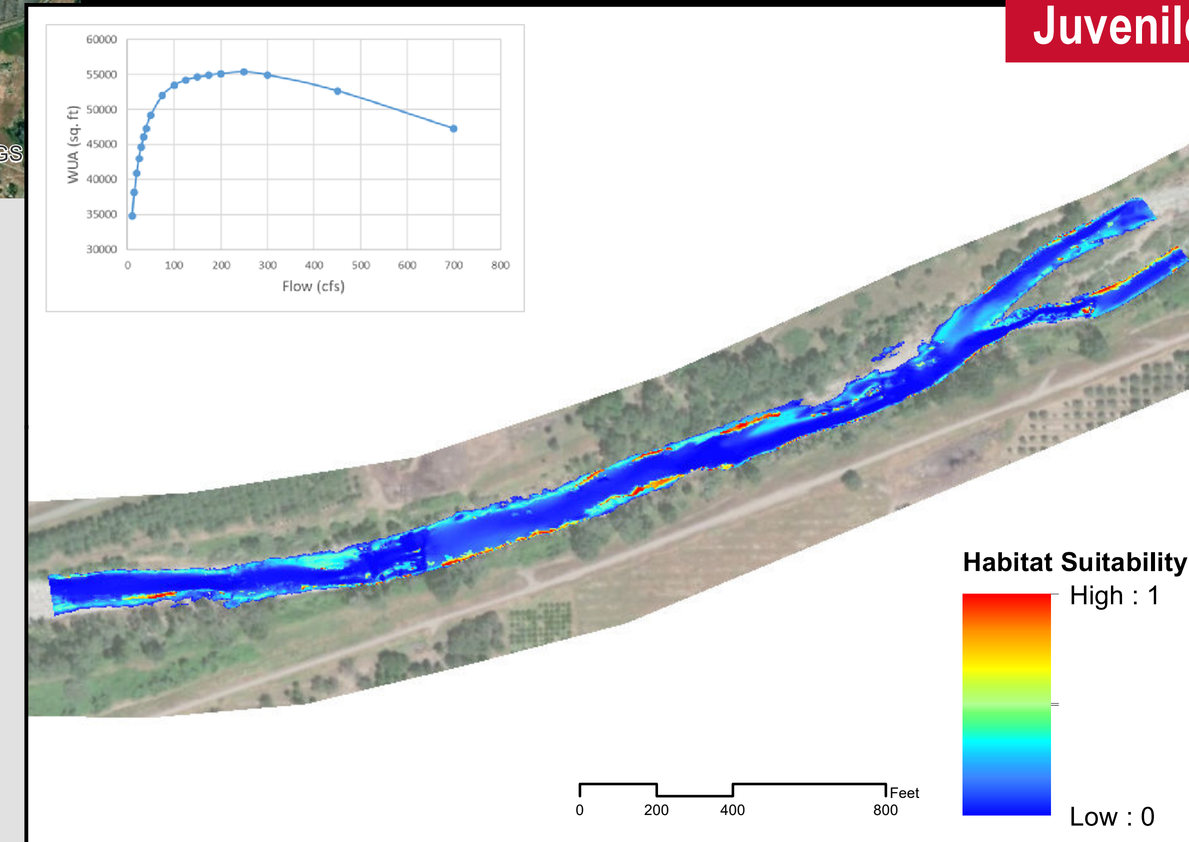
Downstream Study Site 700 cfs



Spawning



Juvenile



Fry