Videography Monitoring of Adult Sturgeon in the Feather River Basin, CA

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Anadromous Fish Restoration Program (AFRP)

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INTRODUCTION

The Anadromous Fish Restoration Program (AFRP) has a goal of supporting efforts that lead to doubling natural production of anadromous fish in the Central Valley (CV), California. Though most efforts of the AFRP have focused on Chinook salmon (*Oncorhynchus tshawytscha*), other anadromous species of increasing concern and interest include green (*Acipenser medirostris*) and white sturgeon (*Acipenser transmontanus*). The Southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*), occurring in the Sacramento River, lower Feather River, and lower Yuba River was listed as a threatened species under the Endangered Species Act (ESA) in June 2006 (NMFS 2006). Since the ESA listing process for green sturgeon began in the early 2000's there has there been a directed effort to understanding the life history and habitat requirements of green sturgeon in the Sacramento River and Sacramento-San Joaquin Estuary. The lower Feather River, a major tributary to the Sacramento River, has been identified as critical habitat for ESA threatened green sturgeon and is believed to have spawning and holding habitat critical for the recovery of this species (NMFS 2008). However, an assessment of the available spawning and holding habitat in the Feather River basin, and their current usage by green sturgeon remains unknown. Similarly, white sturgeon are believed to spawn in the Feather River (Moyle 2002), yet no direct observations have been made.

Green and white sturgeon spend most of their lives in marine waters and have been observed to make long migrations from southeast Alaska to Monterey Bay, California (Moyle 2002; Lindley et al. 2008). Both sturgeon species reach maturity between 12 and 20 years, and only spawn every 2-5 years (Moyle 2002). Sturgeon migrate upstream into the Sacramento River in the winter and early spring in response to increases in flow and spawn from February to July, with peak spawning from April to June (Moyle 2002; Heublein et al. 2009; Poytress et al. 2010). Egg collections imply that green sturgeon in the Sacramento River spawn over medium-sized gravel substrate in depths from 0.8 to 9.4 m (Poytress et al. 2010). Sacramento River white sturgeon have been observed to spawn over substrates ranging from sand to cobble in depths from 0.5 to 5 meters (Schaffter 1997).

Following spawning, green sturgeon have been observed to hold in pools greater than 5 meters deep for an extended period throughout the summer months in the Sacramento River (Hublein et al. 2008), Klamath and Trinity rivers (Benson et al. 2007), and Rogue River (Erickson et al. 2002) and are believed to hold in these areas to feed and conserve energy (Benson et al. 2007; Erickson et al. 2002). Holding sturgeon were observed to outmigrate in the late fall during the first high flow event (Hublein et al. 2008; Benson et al. 2007; Erickson et al. 2002). Some post-spawn green sturgeon have been observed to make an alternative outmigration shortly after spawning in the spring or early summer, and avoid an extended holding period (Hublein et al.

2008; Benson et al. 2007). Unlike green sturgeon, white sturgeon have not been observed to exhibit a summer holding period in the Sacramento River, and appear to outmigrate immediately after spawning (Schaffter 1997).

Recent literature reviews (Klimley et al. 2007; Beamesderfer 2004) have documented a large collection of new research aimed at understanding the biology and life history details of green sturgeon. Recent studies have examined the temperature tolerance of green sturgeon larvae (Werner et al. 2007; Allen et al. 2006) and embryos (Van Eeneennaam et al. 2005). Adult movement and holding behavior of green sturgeon has been examined in the Rogue river (Webb and Erickson 2007; Erickson 2002), Klamath River (McCovey 2009; Benson et al. 2007), and Sacramento River (Heublein et al. 2009). Studies have examined daily movements of adult and sub-adult green sturgeon in the San Francisco Bay Estuary (Kelly et al. 2007) and annual migrations of adult sturgeon in the ocean (Lindley et al. 2008). Evidence of spawning has been observed in the Sacramento River from collections of eggs and larvae (Poytress et al. 2010; Poytress et al. 2009; Brown 2007). Genetic studies have examined the geographic patterns of genetic differentiation among populations of green sturgeon along the West Coast (Israel et al. 2004) and estimated the breeding population size of Sacramento River green sturgeon (Israel and May 2010).

Although green sturgeon presence in the upper Sacramento River has been well documented by direct observation, angler catch, and the consistent presence of eggs, larvae, and young-of-the-year green sturgeon (Beamesderfer et al. 2004), green sturgeon movement and spawning in Sacramento River tributaries is unknown, with the exception of the Feather River, where they are neither common nor consistently observed (Beamesderfer et al. 2004, Moyle 2002). At most, two records have been confirmed of adult green sturgeon in the Feather River (NMFS 2005). Even though no direct evidence exists of past or current green sturgeon spawning in the Feather River (NMFS 2010), it is believed to provide spawning habitat for green sturgeon at least in high flow years (NMFS 2005).

Self-sustaining populations of white sturgeon exist only in the Sacramento, Columbia (Washington), and Fraser (British Columbia) River Basins (Moyle 2002). In California, white sturgeon are most abundant in the San Francisco estuary, with spawning believed to occur mainly in the Sacramento and Feather Rivers (Moyle 2002). White sturgeon spawning and holding habitat has not been characterized in the Sacramento River. However, white sturgeon are known to spawn over deep gravel riffles or in deep holes with swift currents and rock bottoms in other river systems (Moyle 2002). Similar to green sturgeon, very little is known about the frequency of spawning or holding by white sturgeon in the Feather River basin.

Because adult green sturgeon concentrate near the stream-bottom of select deep-water habitat to spawn and hold for an extended period in the spring and summer, they become susceptible to monitoring efforts, particularly remote imaging devices. Monitoring in the Sacramento River is currently underway pairing DIDSON sonar and underwater videography to identify and enumerate spawning and holding green sturgeon. Sonar technology is also being used to observe sturgeon spawning behavior in the Nechako River, British Columbia (Sykes 2010).

Underwater videography has also been used to characterize spawning substrate composition (Poytress et al. 2010; Groves and Chandler 1999). Qualitative assessment of green sturgeon spawning substrate has been conducted in the Sacramento River by performing underwater video transects (Poytress et al. 2010). Underwater videography has also been used to assess spawning substrate used by Chinook Salmon in deep-water habitat (>3 m) in the Snake River (Groves and Chandler 1999).

Our objective is to identify and characterize potential spawning/holding habitat for green and white sturgeon in the Feather and Yuba Rivers and create a protocol for monitoring sturgeon using underwater videography for the 2011 field season. The following is provided in this report: 1) An inventory of the potential sturgeon spawning/holding habitat in the Feather and Yuba Rivers, 2) Methods and findings of a pilot study determining the efficacy of using side-scan sonar technology for monitoring holding sturgeon, 3) Methods and findings from a pilot study conducted on the Sacramento River using underwater video to monitor for holding sturgeon and characterize habitat, including describing bottom substrate, depth, and habitat size, and 4) A proposed 2011 field schedule for monitoring sturgeon spawning/holding habitat in the Feather and Yuba Rivers.

INVENTORY OF POTENTIAL SPAWNING/HOLDING HABITAT

Potential sturgeon spawning and holding habitat in the Feather and Yuba Rivers was inventoried in the summer of 2011 by floating the extent of each river accessible to adult sturgeon. Because literature suggests that post-spawn green sturgeon hold in freshwater at depths greater than 5 m across the range of their habitation (Hublein et al. 2008; Benson et al. 2007; Erickson et al. 2002), sites that exhibited depths greater than 5 meters were considered to provide potential sturgeon holding habitat. Although using a depth criteria to inventory habitat across several months under differing flow conditions could be problematic (i.e. depths vary with flow), mean daily flow conditions did not vary greatly during our study (6,485-6,649 cfs). The depth profile of potential sturgeon habitat was mapped by making multiple passes across the habitat to ensure complete coverage, and recording a depth measurement every second using a Lowrance LMS-520c sonar unit.

Depth and locations from sonar habitat mapping were imported into ArcGIS 10 software package creating a point file feature. A polygon feature of the study area was created in ArcGIS by digitizing and tracing the boundary of the river. This digitized polygon was overlaid into the depth point feature data set as the fixed boundary of the habitat site and processed as a triangulated irregular network (TIN) for raster generation. Water depths values in raster file format were then reclassified to the following water depth categories: < 3 m, 3-4.9m, 5-6.9 m, 7-8.9 m, and ≥ 9 m. For each habitat site, the area of habitat exhibiting depths greater than or equal to 5 m was calculated using ArcGIS. The minimum home range observed for holding green sturgeon in the Rogue River was 50 X 50 m (2500 m^2; Erickson et al. 2002). Therefore, we considered habitat sites that exhibited depths greater than or equal to 5 m over a minimum area of 2500 m^2 as potential sturgeon habitat.

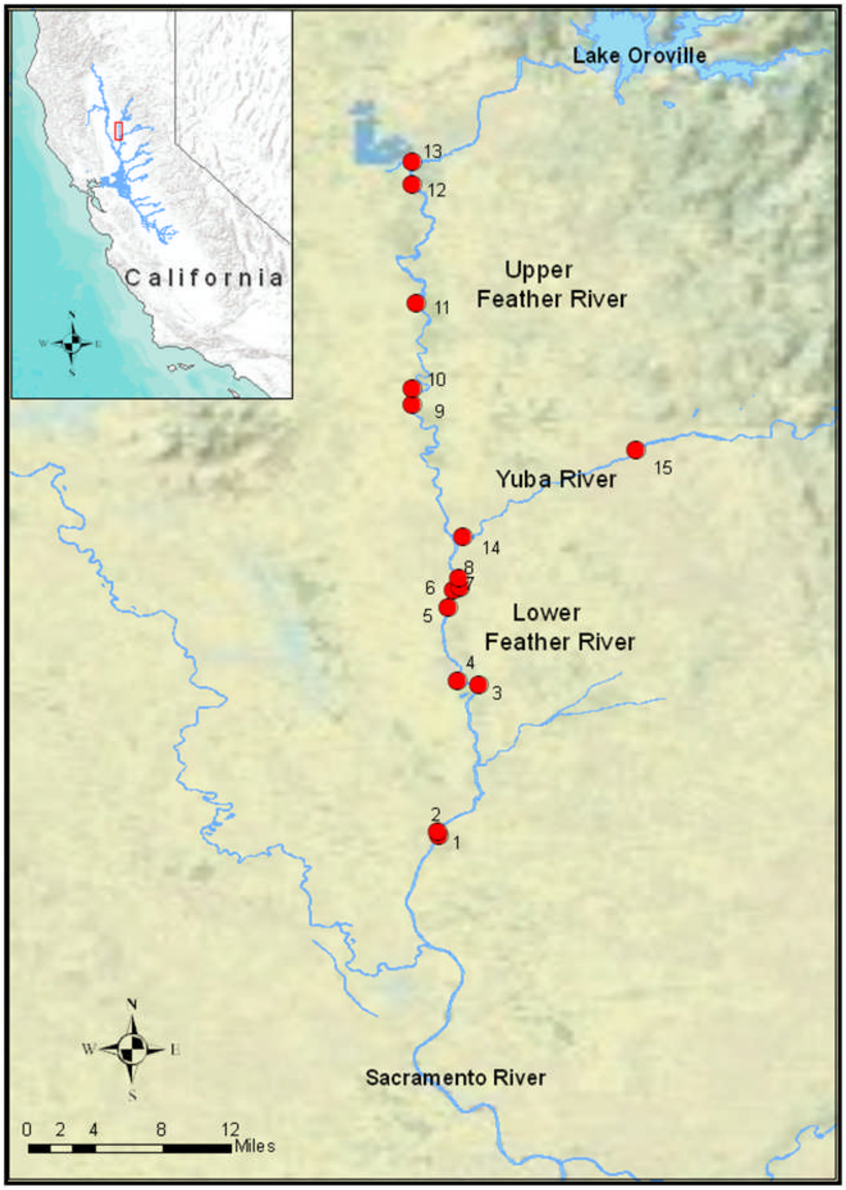


Figure 1. Location of 15 potential sturgeon holding/spawning habitat sites identified in the Feather and Yuba rivers. The study area was separated into three segments: 1)Lower Feather River (confluence with Sacramento River upstream to confluence with Yuba River), 2) Upper Feather River (confluence with Yuba River upstream to Oroville Dam), and 3) Yuba River (confluence with Feather River upstream to Daguerre Dam).

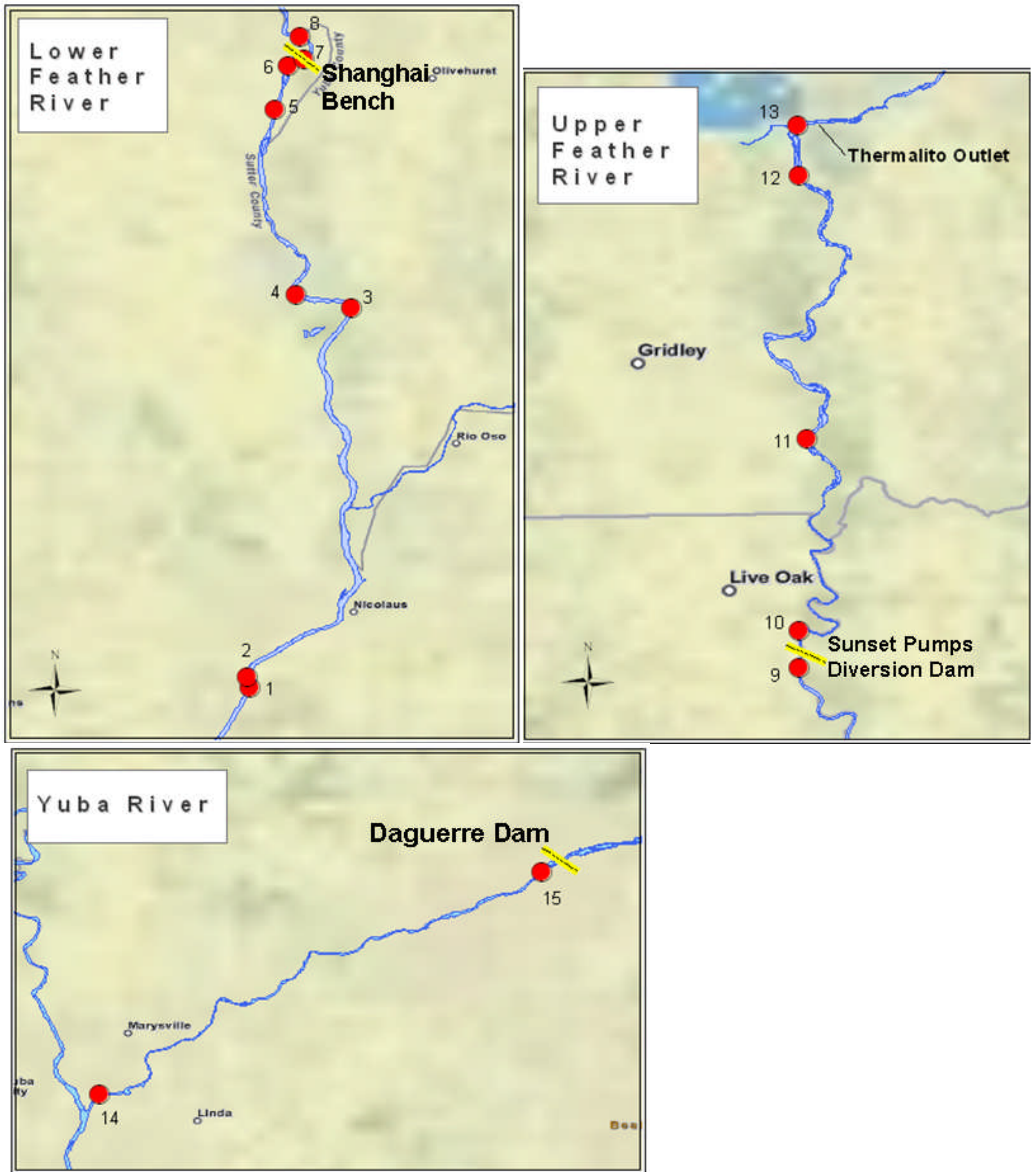


Figure 2. Location of potential sturgeon holding/spawning habitat sites in the Lower Feather River, Upper Feather River, and Yuba River. Also depicted are the two fish barriers on the Feather River (Shanghai Bench and Sunset Pumps Diversion Dam), the fish barrier on the Yuba River (Daguerre Dam), and the Thermalito Outlet on the Feather River, which is the outlet for the Thermalito Afterbay.

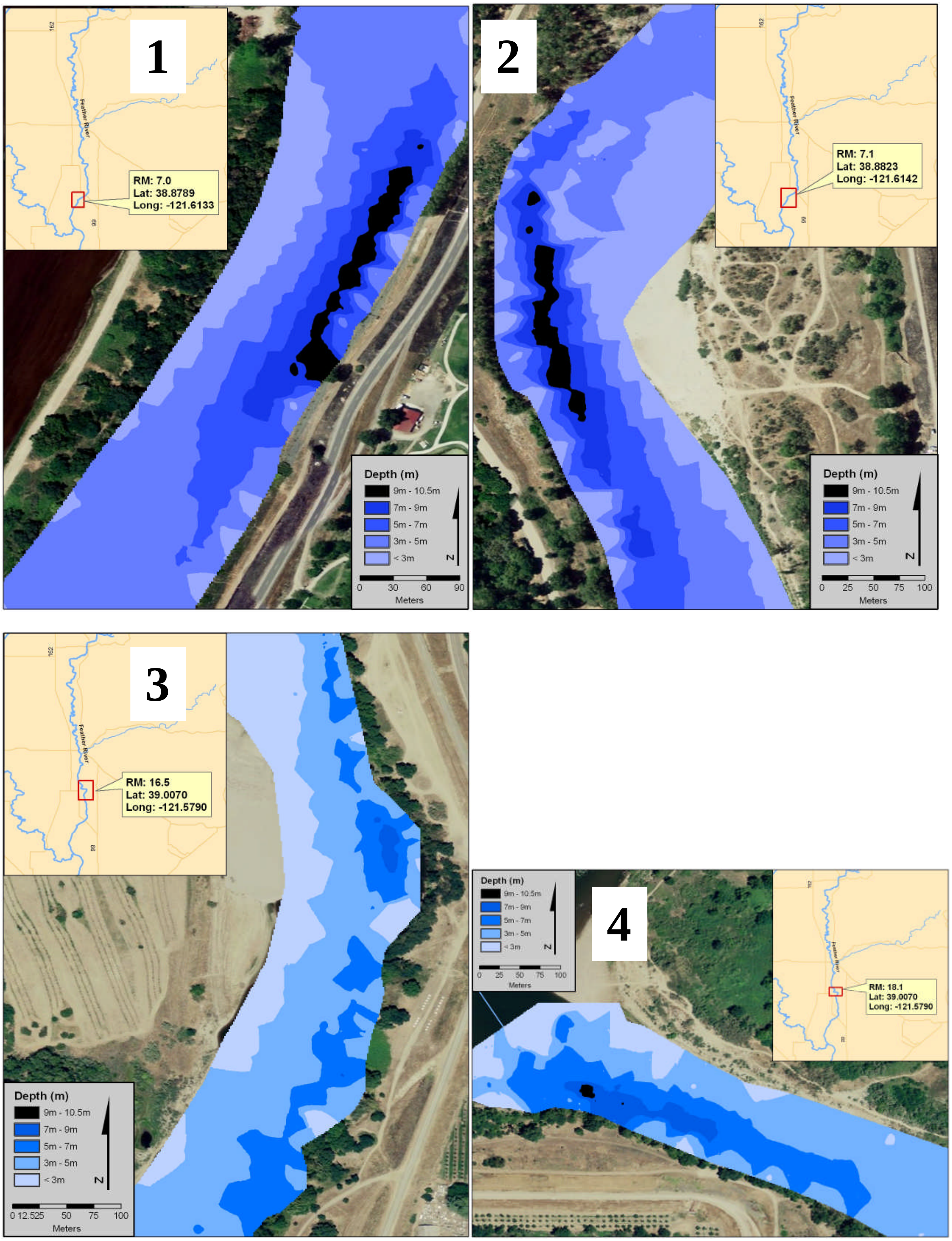
Thirteen habitat sites were identified in the Feather River, and 2 sites in the Yuba river (Table 1; Figures 1 and 2). Habitat sites in the Feather River were identified across nearly the entire extent of river habitat available to sturgeon (7 – 59.2 River Kilometer; RKM). Two habitat sites are located below potential sturgeon barriers, the Sunset Pumps diversion dam (#9; 39.1 RKM) and Shanghai Bench (#6; 24 RKM). Both Sunset Pumps and Shanghai Bench were identified as potential upstream migration barriers for sturgeon, except possibly under high river flows where they may become passable (SWRI 2003). Other habitat sites of note were 2 sites (#7 and #8) located at the deepwater habitat immediately upstream of the Shanghai Bench (RKM 24.3), known to local fishers as Shanghai Bend, and habitat site (#13) at the scour pool formed by the Thermalito Outlet, which is the outlet of the Thermalito Afterbay at RKM 59.2. Maximum depths at the Feather River habitat sites ranged from 7.5 – 10.5 m (Table 1).

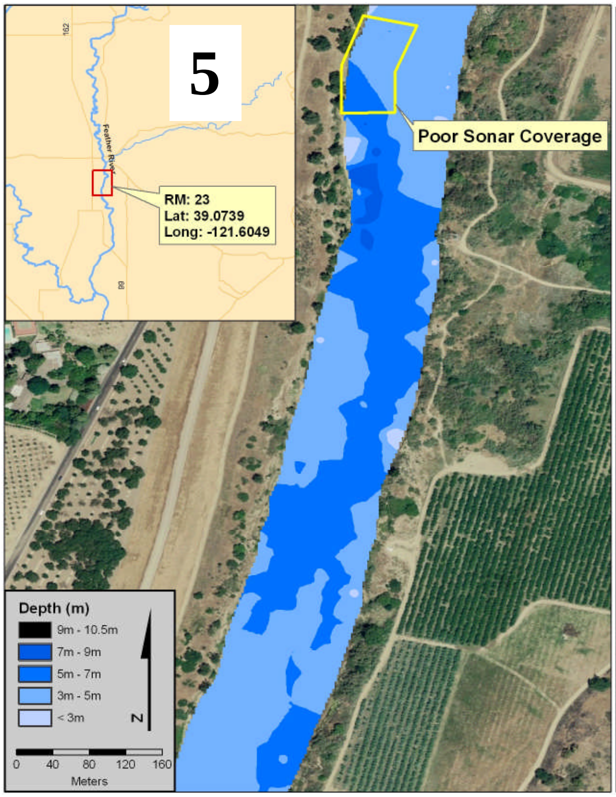
Only 2 habitat sites (#14 and #15) were identified in the Yuba River (Table 1; Figures 1 and 2). Although the upstream site (#15) did not meet the depth criteria established for being considered sturgeon habitat (max depth = 4 m), the site was included because of its location immediately below Daguerre Dam, a barrier to upstream sturgeon migration.

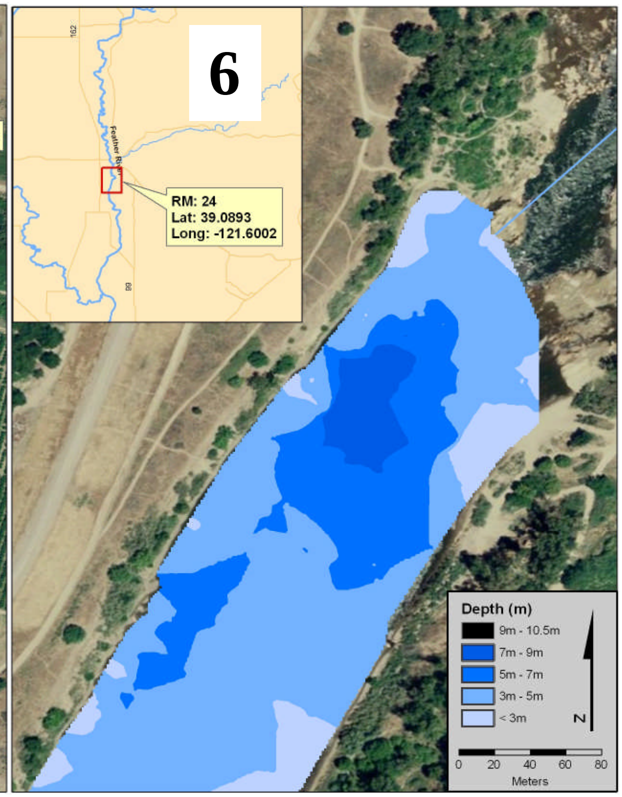
Table 1. Potential sturgeon holding/spawning habitat sites identified in the Feather and Yuba rivers during summer 2010.

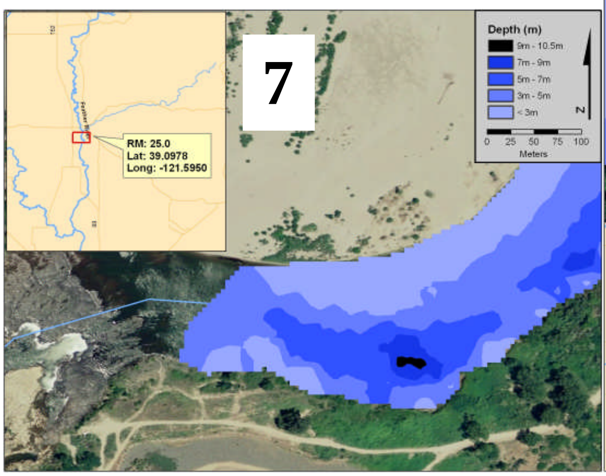
ID	Latitude	Longitude	RKM	River	Max Depth	Comments
1	38.87890	-121.61330	7	Feather River	10	
2	38.88230	-121.61420	7.1	Feather River	9.5	
3	39.00700	-121.57900	16.5	Feather River	8	
4	39.01140	-121.59760	18.1	Feather River	9.5	
5	39.07390	-121.60490	23	Feather River	7.5	
6	39.08879	-121.60047	24	Feather River	8	Below Shanghai Bench
7	39.09090	-121.59530	24.4	Feather River	9	Shanghai Bend Lower
8	39.09860	-121.59650	25	Feather River	10.5	Shanghai Bend Upper
9	39.24710	-121.63600	39.1	Feather River	9.5	Below Sunset Pumps
10	39.26130	-121.63580	40	Feather River	7.5	
11	39.33450	-121.63300	48.1	Feather River	9	
12	39.43560	-121.63610	57.8	Feather River	9.5	
13	39.45490	-121.63640	59.2	Feather River	10	Thermalito Outlet
14	39.13400	-121.59300	0.5	Yuba River	6	
15	39.20870	-121.44410	11.4	Yuba River	4	Below Daguerre Dam

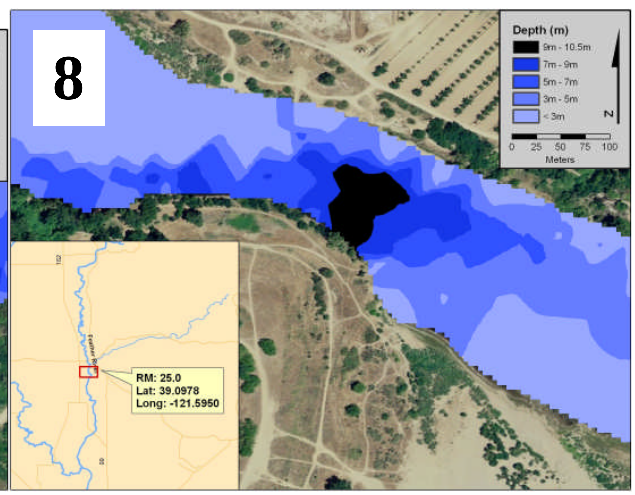
The following figures depict the depth profiles for each of the 15 habitat sites identified in the Feather and Yuba rivers.

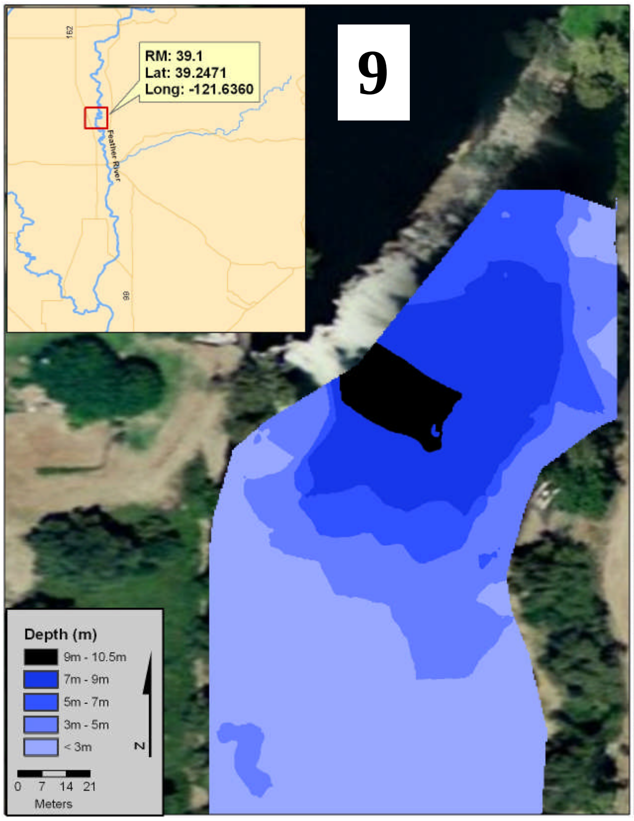

1
Feather River
RM: 7.0
Lat: 38.8789
Long: -121.6133
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 30 60 90
Meters
2
Feather River
RM: 7.1
Lat: 38.8823
Long: -121.6142
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 25 50 75 100
Meters
3
Feather River
RM: 16.5
Lat: 39.0070
Long: -121.5790
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 12.525 50 75 100
Meters
4
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 25 50 75 100
Meters
RM: 18.1
Lat: 39.0070
Long: -121.5790

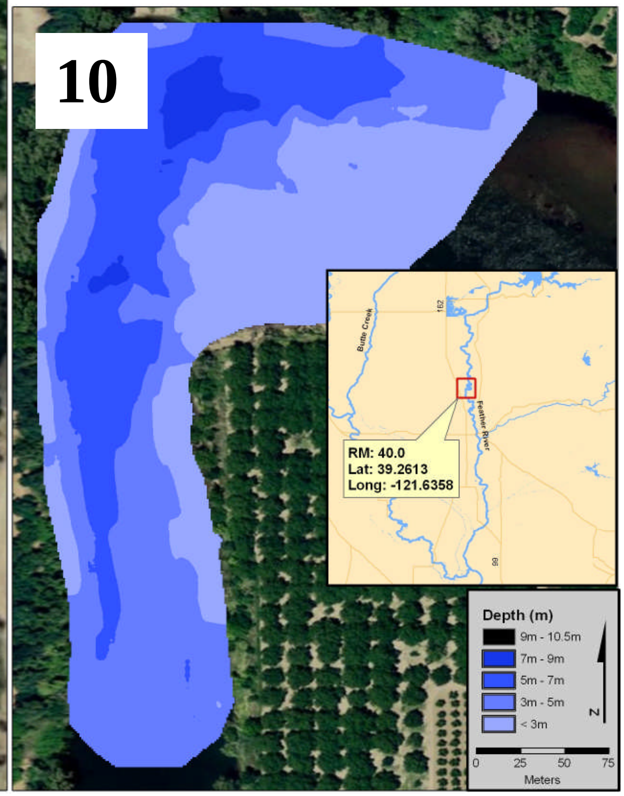

5
Poor Sonar Coverage
RM: 23
Lat: 39.0739
Long: -121.6049
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 40 80 120 160
Meters

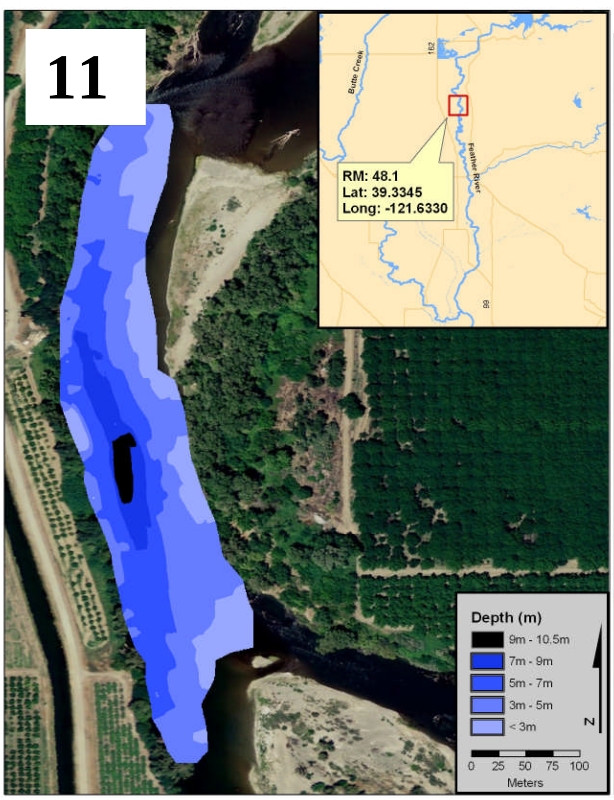

6
RM: 24
Lat: 39.0893
Long: -121.6002
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 20 40 60 80
Meters

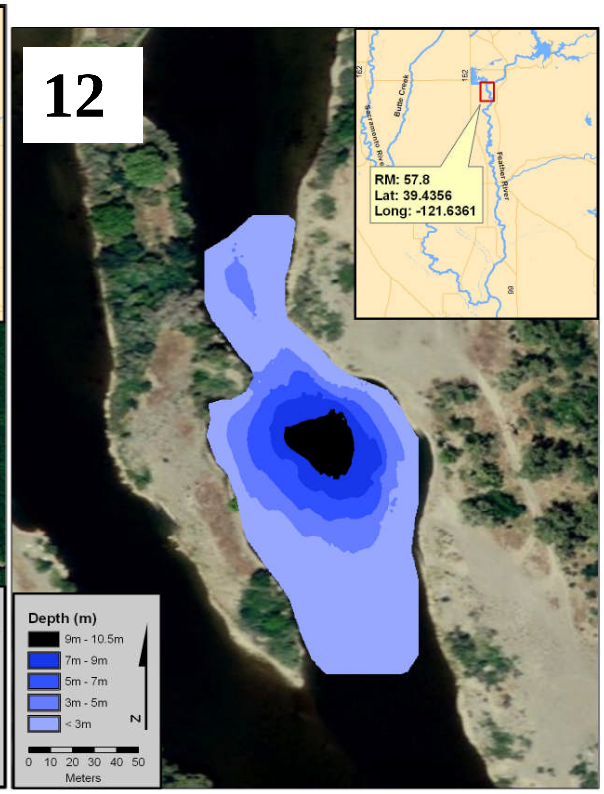

7
RM: 25.0
Lat: 39.0978
Long: -121.5950
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 25 50 75 100
Meters


8
RM: 25.0
Lat: 39.0978
Long: -121.5950
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 25 50 75 100
Meters


9
RM: 39.1
Lat: 39.2471
Long: -121.6360
Feather River
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 7 14 21
Meters


10
Butte Creek
Feather River
RM: 40.0
Lat: 39.2613
Long: -121.6358
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 25 50 75
Meters


11
Butte Creek
Feather River
RM: 48.1
Lat: 39.3345
Long: -121.6330
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 25 50 75 100
Meters


12
Butte Creek
Feather River
RM: 57.8
Lat: 39.4356
Long: -121.6361
Depth (m)
9m - 10.5m
7m - 9m
5m - 7m
3m - 5m
< 3m
N
0 10 20 30 40 50
Meters

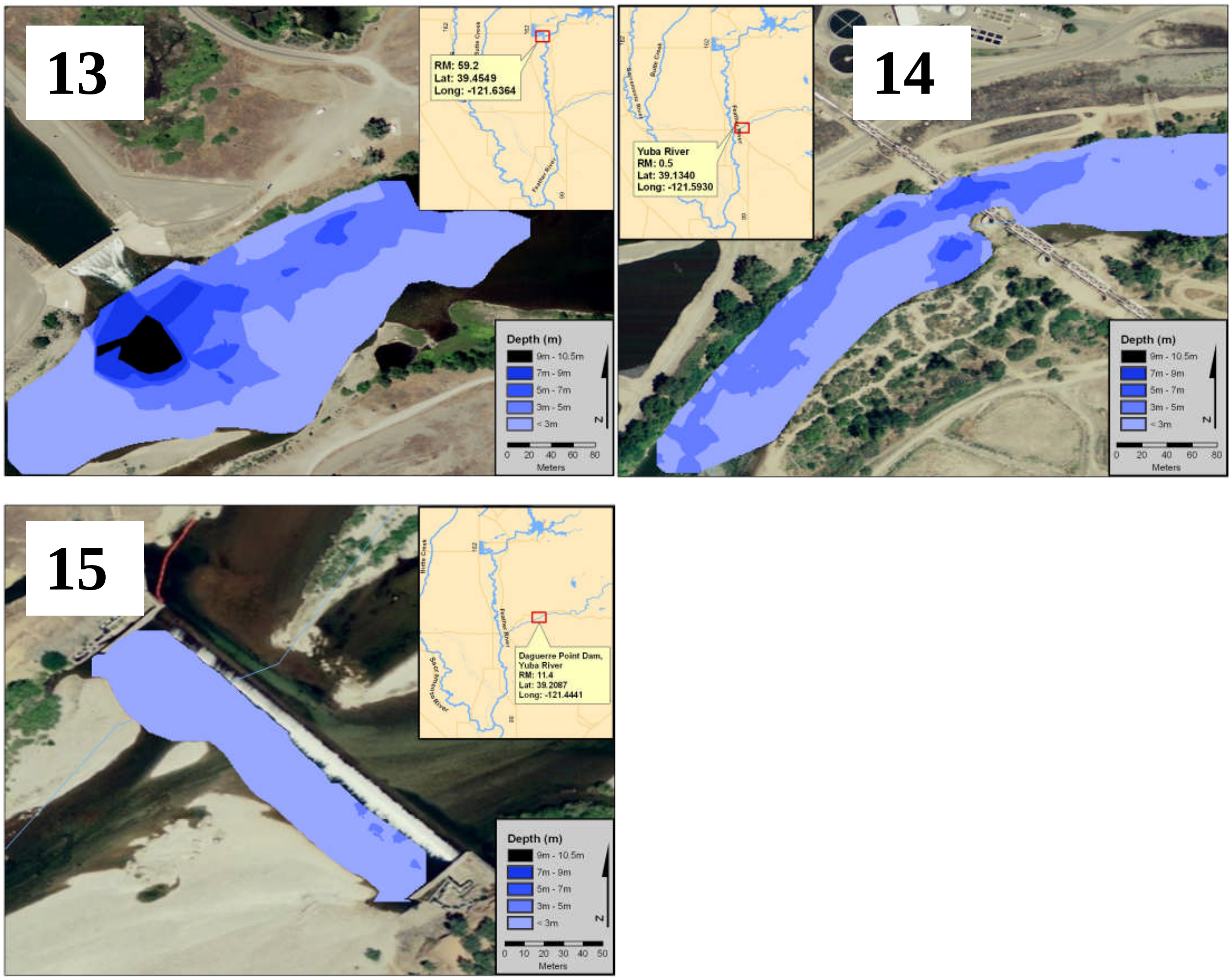


Figure 3. Depth profiles for all 15 potential sturgeon holding/spawning habitats in the Feather and Yuba Rivers. The following depth increments are depicted: <3 m, 3-4.9 m, 5-6.9 m, 7-8.9 m, and 9-10.5 m.

PILOT STUDIES

Side-scan Sonar

Methods

We conducted a pilot study in the Yuba River to determine the efficacy of using side-scan sonar technology to monitor holding sturgeon. We chose to conduct the study in the Yuba River under low flow and high clarity conditions to test the ability of the sonar technology to identify sturgeon under ideal conditions.

We purchased a 112 cm, 11.4 kg, post-spawn, male white sturgeon from Sterling Caviar in Sacramento, CA. The sturgeon was killed and frozen for 48 hours. We thawed the sturgeon for 8 hours and tethered the sturgeon to an anchor with a 2 foot lead to allow the sturgeon to suspend slightly off the bottom behind the anchor to mimic a holding sturgeon. The sturgeon was placed at a pool at RKM 3.1 in the Yuba River on June 22, 2010. Water turbidity was measured at the site.

We employed a Lowrance StructureScan sonar unit to obtain sonar data. The sonar transducer was positioned at the rear of the boat at an operating frequency of 800 kHz, and the side beam range was set to auto, to automatically adjust to the width of the river channel. We made two upstream passes at slow speed (1-2 km/hr), with the sturgeon on different sides of the boat for each pass. We also lowered the video camera to verify the position of the white sturgeon. Side-scan images were later reviewed to visually identify the tethered white sturgeon.

Results

We were able to successfully record side-scan sonar imagery for 2 passes at the Yuba River site. The sturgeon was placed at a depth of 4.1 meters. Turbidity at the site measured 1.47 NTU. Underwater video verified that the dead sturgeon was suspended slightly (~ 1 foot) off the bottom behind the anchor.

The tethered, dead white sturgeon was not identified in the sonar imagery. However, bottom substrate variability and large woody debris that were observed in the field were clearly observed in the sonar images.

Conclusions

By not being able to detect a tethered, dead adult sturgeon under ideal conditions (low flow, high clarity), we were able to determine that Lowrance StructureScan technology likely will not be an effective sampling method for holding sturgeon in the Feather River Basin. The relatively small size (1.1 meters) of the tethered sturgeon may be too small to be identified by the sonar technology. It is possible that the sonar technology could identify older, larger holding sturgeon, however, the size of the sturgeon used was within the range of an average sized green sturgeon identified by Moyle (2002).

Underwater Videography

Methods

We conducted a pilot study in the Sacramento River to determine the efficacy of using underwater videography to monitor holding green and white sturgeon and to characterize bottom substrate. We chose to conduct our study in the Sacramento River, where sturgeon holding (Heublein et al. 2009) and spawning (Brown 2007; Poytress et al. 2009; Poytress et al. 2010) have been well documented. We conducted the pilot study on September 10, 2010, in the Sacramento River at a complex of deepwater habitat located upstream of the GCID diversion facility at RKM 331, which was identified by Heublein et al. (2009) as being perennial summer holding habitat for green sturgeon.

First, we mapped the depth profile of the habitat site using sonar (as described previously for Feather River Basin sites). Water turbidity was measured using a Hach 2100P portable turbidity meter and water temperature was measured using the Lowrance sonar unit. Additionally, water clarity was estimated by lowering and raising a secchi disk in the water column and calculating the average depth of disappearance and reappearance (McMahon et al. 1996). The video habitat survey was performed using a Splash Cam© Deep Blue Pro underwater camera attached to 30 m of video and power cable. The video camera, along with a 4.5 kg ballast weight attached to its base for stability, was suspended from the port side of the boat. A Cannon Mag 5HS electric downrigger was used to raise and lower the camera in the water column during deployment. Video images were recorded on a EverFocus ECOR 4D 465 GB DVR unit with GPS and time overlay and displayed in real-time on a 38 cm LCD monitor.

The video survey consisted of a single pass upstream through the habitat site. The camera was lowered (facing upstream) in the water column until the river bottom was visible in the lower 1/3 of the image on the LCD monitor. The survey progressed slowly upstream (1- 2 km/hr) through the habitat site with the video camera being raised and lowered using the electric downrigger to keep the river bottom in the lower 1/3 of the LCD monitor’s image. A GPS track was saved simultaneous with the video survey to track the boat’s location during the entire transect. At the end of the survey, the video camera was raised to the water surface or secured onboard.

Video footage was later reviewed to identify fish and bottom substrate type. The GPS position, time observed, and species were recorded for each identified fish. Fish GPS positions were imported into ArcGIS 10 software package and a point file feature was created. The habitat depth at each fish location was determined by overlaying the fish locations with the depth raster coverage. Video footage was reviewed for dominant substrate type using substrate descriptors used by Poytress et al. (2010) for green sturgeon spawning substrate in the Sacramento River. Substrates were visually classified as sand (<2.0 mm), gravel (2.0 to 63.9 mm), cobble (64.0 to 256.0 mm), boulder (>256.0 mm), and hard pan. We considered a dominant substrate type as one that filled more than 55% of the video image (Groves and Chandler 1999). Times of transition between different dominant substrate types were noted and the percent substrate composition was calculated as the percentage of time each dominant substrate type was observed. During periods when the camera lost a visual image of the river bottom the previous dominant substrate type was assumed.

Results

The maximum of depth of the Sacramento River habitat site was 10 meters, with approximately 17,600 m^2 of habitat deeper than 5 m. Water clarity was 5 m, turbidity was 1.75 NTU, water temperature was 14.2^{o}C, and Sacramento River flow measured at Bend Bridge (RKM 415) was 8,745 cfs (California Department of Water Resources) during the underwater video survey.

The underwater video survey transect was 580 meters long, and began at 10:31 AM and completed at 10:55 AM, for a total survey time of 24 minutes, 9 seconds, . On five occasions during sampling, the video camera was raised to avoid collision with an obstruction and visibility of the river bottom was lost for a period of time. Lost visibility accounted for 3 minutes, 2 seconds of time, which was 12.6% of the survey time. The video transect was 580 meters long

A single white sturgeon and 10 adult Chinook salmon were identified during playback of the video footage (Table 2; Figures 4-6). The white sturgeon was observed at the river bottom at 6.7 meters deep, and Chinook salmon were observed in habitats with depths ranging from 3.8 – 9.5 meters (mean = 6.9 meters). All fish were observed over gravel substrate.

Table 2. Fish observed during underwater video survey on September 10, 2010 in the Sacramento River at the deepwater complex upstream of the GCID diversion facility (RKM 331), and their associated location, time observed, depth, and bottom substrate.

Species	Y	X	Time	Depth (m)	Substrate
Chinook Salmon	39.809118	-122.061770	10:32:39	9.5	gravel
Chinook Salmon	39.809157	-122.061905	10:34:58	9.1	gravel
Chinook Salmon	39.809413	-122.062372	10:37:28	8.0	gravel
Chinook Salmon	39.809550	-122.062687	10:39:13	7.3	gravel
Chinook Salmon	39.809577	-122.062723	10:39:22	6.7	gravel
Chinook Salmon	39.809837	-122.063030	10:41:22	6.3	gravel
Chinook Salmon	39.809837	-122.063030	10:41:23	6.3	gravel
Chinook Salmon	39.809842	-122.063030	10:41:25	6.3	gravel

White Sturgeon	39.810565	-122.064207	10:47:50	6.7	gravel
Chinook Salmon	39.810680	-122.064220	10:50:54	5.1	gravel
Chinook Salmon	39.810595	-122.064455	10:52:32	3.8	gravel

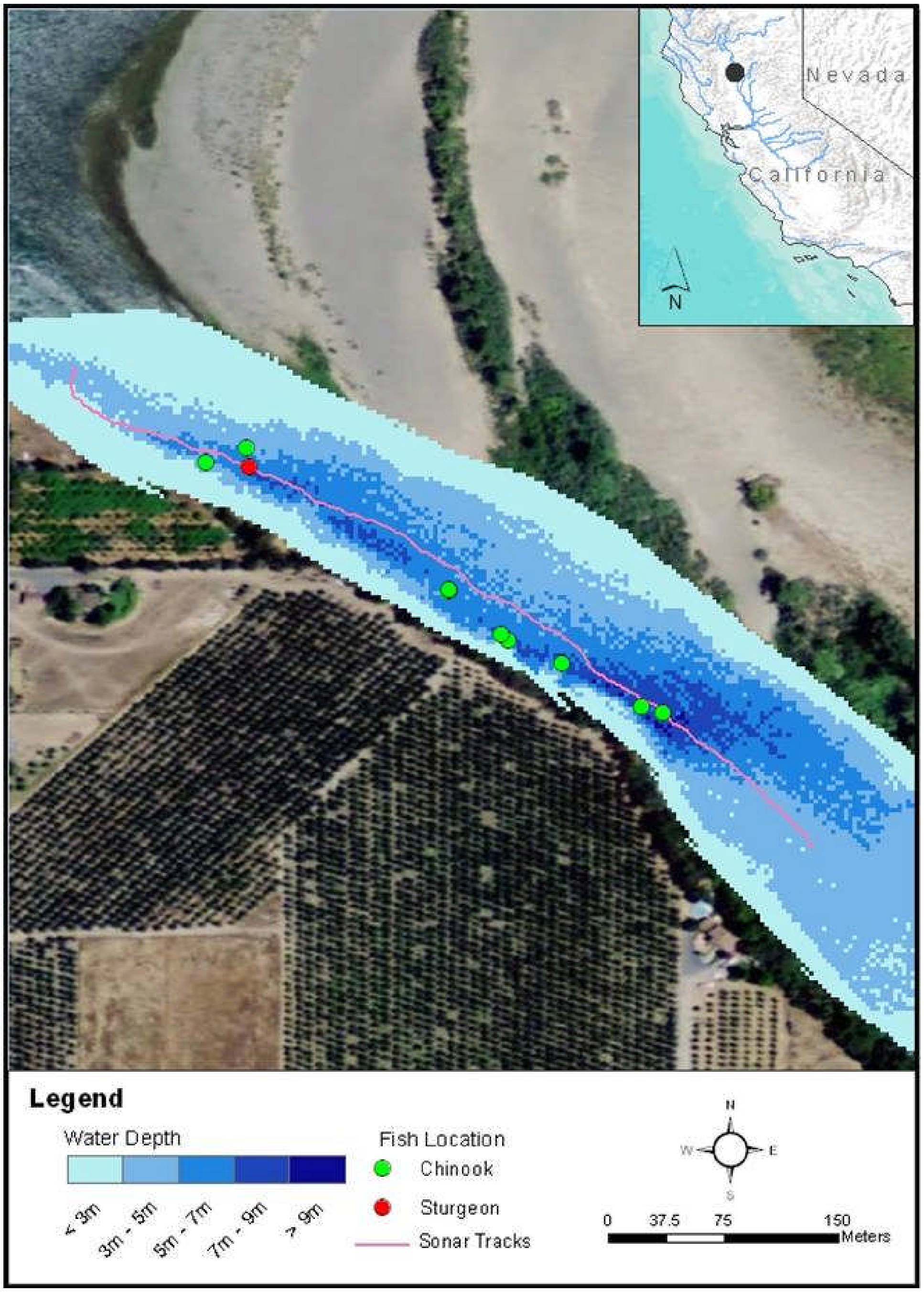


Figure 4. Depth profile, observed fish locations, and sonar track of underwater video survey conducted on September 10, 2010 in the Sacramento River at the deepwater complex upstream of the GCID diversion facility (RKM 331).

Figure 5. Two views of a white sturgeon observed using underwater videography on September 10, 2010 in the Sacramento River at the deepwater complex upstream of the GCID diversion facility (RKM 331).

Figure 6. Two of the 10 Chinook salmon observed using underwater videography on September 10, 2010 in the Sacramento River at the deepwater complex upstream of the GCID diversion facility (RKM 331).

The bottom substrate was primarily composed of gravel, with gravel the dominant substrate type during 91.6% of the video survey. Sand (7.7%) and hard pan (0.7%) comprised the remainder of the substrate types observed.

Conclusions

Underwater videography proved effective for observing holding sturgeon and other key fish species in the Sacramento River. A single white sturgeon was observed, along with 10 Chinook salmon. The turbidity in the Sacramento River was relatively low (1.75 NTU) during sampling, and it remains to be seen how effective video monitoring will be under lower water clarity. Although this pilot study proves that this methodology can be effective at confirming presence of holding sturgeon, the probability of detection is unknown, and therefore, these methods currently would not be useful for estimating abundance, or confirming fish absence. Further research is required to calculate the probability of detecting holding sturgeon for this methodology under a wide range of possible stream conditions.

Underwater videography also proved effective for qualitatively evaluating bottom substrate. We were able to characterize the substrate composition of the habitat site, similar to Poytress et al. (2009; 2010). We were also able to determine the substrate type and depth associated with each observed fish. During the pilot study, reference lasers mounted on the camera were unavailable to verify substrate size, but will be used in future sampling efforts.

Applying this methodology to sites across the Feather River Basin during the sturgeon spawning/holding period, would provide information on sturgeon habitat usage in the Feather River Basin, and provide critical information about fish-habitat associations. This knowledge would help guide future habitat conservation projects and future monitoring efforts for white sturgeon and the Threatened Southern DPS green sturgeon.

2011 PROPOSED FIELDWORK

We intend to apply the above video sampling methodology to the 15 identified potential holding/spawning habitat sites in the Feather River Basin. We will sample all sites once a month through the spawning and holding period (March – September). Also, once a month we will sample 2 sites in the Sacramento River that have been observed to perennially provide habitat for spawning and holding sturgeon: the deepwater complex above GCID (RKM 331; Heublein et al. 2009) and at the mouth of Antelope Creek (RKM 377; Poytress et al. 2009). Because sturgeon are known to hold and spawn in these Sacramento River sites in high numbers, these sites will provide a comparison of fish timing and relative habitat usage to Feather River sites.

Sampling for the 15 Feather River Basin sites, and two Sacramento River sites will be completed in a single week, once each month (March – September), for a total of 7 weekly sampling efforts, totaling 35 days of effort. Sampling within each month will occur during the first week flow conditions permit safe sampling, and turbidity levels are low enough (approximately < 5 NTU) for underwater viewing.

Any observations of sturgeon in the Feather River will be reported to Alicia Seesholtz of the DWR to assist with their sturgeon tagging efforts. We will provide field assistance to the DWR for any subsequent fish capture and tagging.

Additionally, 3 field days throughout the field season will be devoted to examining the detection probability of the sampling gear. Each sampling day, known numbers of "dummy" sturgeon will be deployed throughout the experimental site, and multiple survey replicates will be conducted to determine sampling accuracy. Three days will be chosen under differing flow conditions, to examine how probability of detection varies with changing turbidity levels.

Table 2. Proposed Budget for 2011.

	$100.00	$89.00	$166.00						
	Biologist III	Biologist II	Sr. Scientist IV	Labor	Expenses				
Objectives and Tasks				Subtotal	Phone	Travel and lodging	Boat Fuel	Video Equipment	Totals
Objective 1: Sturgeon Monitoring									
Task 1.1 Field Preparation	40	60		$9,340					
Task 1.2 Field Sampling	304	304	8	$58,784		$5,000	$800	$500	$65,084
Task 1.3 Coordinate with DWR tagging	34	24		$5,536	$20				$5,556
Objective 1 Subtotal	378	388	8	$73,660	$20	$5,000		$500	$79,180
Objective 2: Project Management and Report									
Task 2.1 Project Management	40			$4,000					$4,000
Task 2.2 Complete annual report	120	80	16	$21,776	$20				$21,796
Objective 3 Subtotal	160	80	16	$25,776	$20	$0			$25,796
Project Totals	**538**	**468**	**24**	**$99,436**	**$40**	**$5,000**	**$0**	**$500**	**$104,976**

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