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M e m o r a n d u m

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Subject: 2017 Sacramento River Sturgeon Spawning Survey - Egg Mat Pilot Study

Purpose

The purpose of this report is to document findings regarding a pilot study to determine white sturgeon (*Acipenser transmontanus*) spawning locations in the Sacramento River and the associated temporal, spatial, and habitat parameters.

Background

White sturgeon (*Acipenser transmontanus*) populations have been severely reduced due to dams blocking access to much of their historical spawning grounds, diversions which entrain larval and juvenile sturgeon, habitat degradation, a legacy commercial fishery; legal sport harvest and illegal harvest (poaching). White sturgeon is a California state species of concern, and is an important recreational fishery managed by CDFW. Recent white sturgeon population monitoring and population modeling data show a continued downward decline in the number of adult spawners in California (Blackburn et. al., 2018). The Sacramento River system is the primary river system supporting spawning of white sturgeon. The majority of white sturgeon are thought to spawn in the middle Sacramento River between Knights Landing (RK 142) and Colusa (RK 237) between mid-February and June (Schaffter 1997). However, no sturgeon spawning surveys have been conducted on the middle Sacramento River since the early-1990s.

White sturgeon are aggregate broadcast spawners and typically spawn in deep pools or runs over gravel, cobble or bedrock substrates with swift or complex currents. Eggs are round or nearly so, black or dark gray in color, with diameters ranging from 3.2 mm to 4.0 mm (Van Eenennaam et al 2006). Upon contact with water, the egg's surface becomes adhesive and they readily stick to bottom substrates upon contact.

Methods

CDFW North Central Region staff reviewed the report of findings of Schaffter (1997), Kohlhurst (1976) and bathymetry data to determine potential spawning sites in the Sacramento River reach from Knights Landing to Tisdale. Site selection for egg mat deployment was based on flow habitat type (e.g., pool, deep run), water depth, and to a lesser extent, substrate composition. Suitable sturgeon spawning habitat typically consists of pools or deep runs with depths ranging from 1.8 to 11.2 meters and flow velocities of ≥ 1.0 meter per second with substrates consisting of gravel, cobble, and boulder (Poytress 2013, Schaffter 1997). Prior to the initial deployment of egg mats, CDFW staff conducted reconnaissance surveys using dual frequency identification sonar (DIDSON) to locate sturgeon aggregations and determine substrate composition at potential sampling sites.

Egg mats were constructed by securing a furnace filter insert to a 76 × 107 × 5-cm rectangular steel frame; the mats were rigged with a 9.5-mm diameter braided polypropylene rope attachment bridle, 9.5-mm diameter buoy line of sufficient length, and a 25-cm diameter inflatable buoy to mark the egg mat location and facilitate retrieval. Once a suitable sampling site was selected, the mat was deployed by gradually lowering it to the river bottom from the stern of the boat while holding the boat stationary in the current. When the egg mat reached the river bottom, the buoy and remaining buoy line were deployed and observed for several minutes to insure the egg mat remained in place. Deployment date and time, GPS coordinates; and water depth and temperature were recorded at each sampling site. GPS coordinates, river depth and water temperature were measured with a Humminbird® multi-function depth-finder. Surface water velocity was estimated to the nearest 0.3 meter per second by observing floating debris, and substrate composition was determined from DIDSON imagery taken at the sampling sites. River discharge in cubic feet per second (cfs) was recorded from the CDEC Sacramento River gage at Colusa (CDEC 2017). A total of nine sites were selected for sampling during the study **Figures 1 and 2**).

Egg mats were retrieved every three to eight days over the duration of the sampling period. Once the egg mats were hauled on board, two crew members conducted a thorough visual inspection for sturgeon eggs attached to furnace filter material and mat frame. Both sides of each mat were checked, and any vegetation such as cocklebur seeds (*Xanthium strumarium*) and small woody debris were removed from the mats prior to re-deployment.

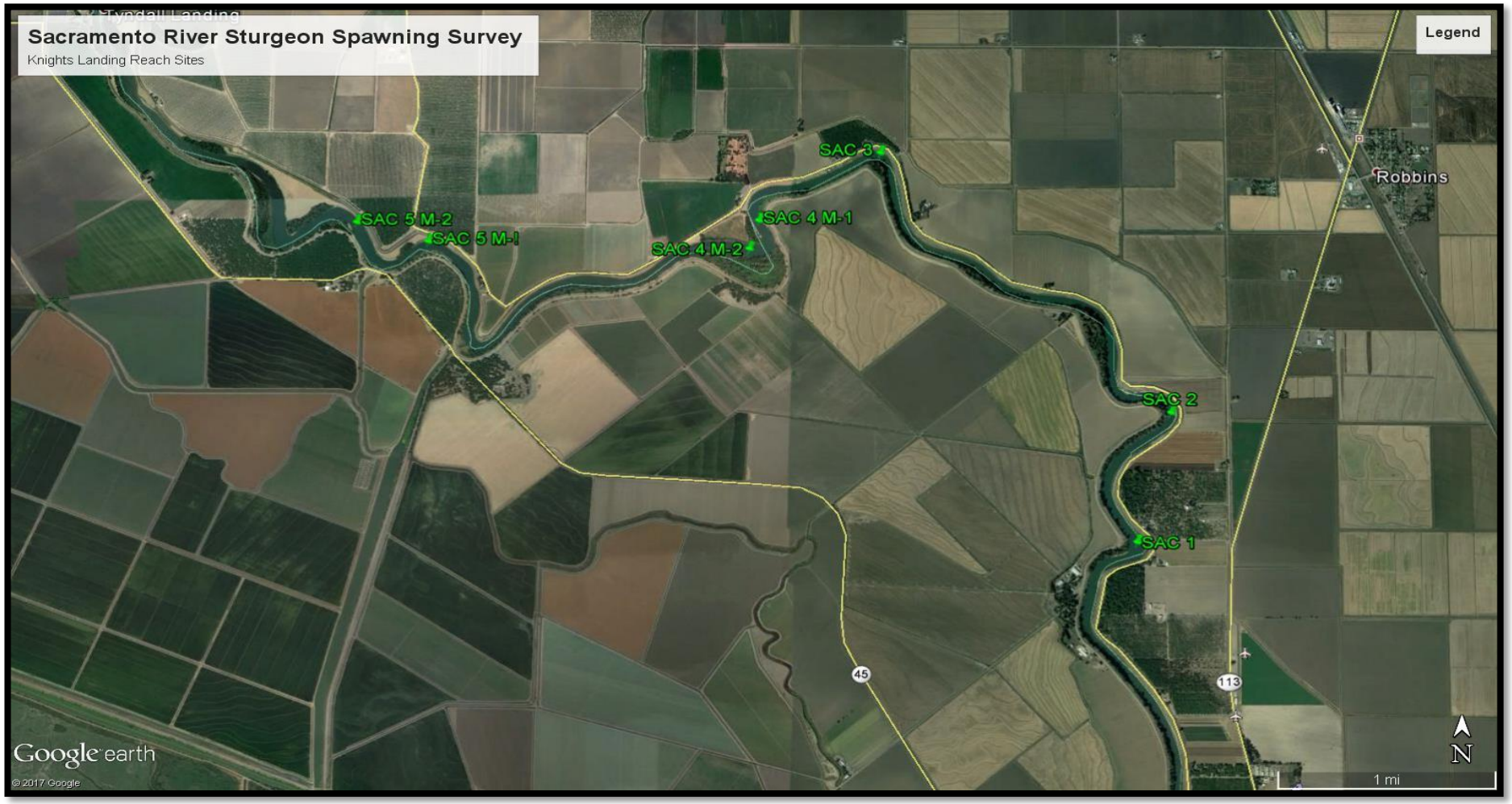

Figure 1. Knights Landing Reach Sites, 2017 Sacramento River Sturgeon Spawning Survey.

Figure 2. Boyer's Landing Reach Sites, 2017 Sacramento River Sturgeon Spawning Survey

Results

Sacramento River flows during the survey period ranged from a low of 8,727 cfs on 21 June 2017 to high of 36, 979 cfs on 22 April 2017 **(Figure 3**). Water temperatures over the duration of the survey period ranged from 12.2° C on 14 April 2017 to 23.5° C, on 21 June 2017, which is within the water temperature range documented during spawning events for white sturgeon (Jackson et. al. 2015, Shaffter 1997), (**Figure 4**). Habitat parameters such depth and current velocity at sites selected for egg mat deployment were consistent with white sturgeon spawning habitat parameters reported in the literature. Substrate composition at the sampling sites consisted mainly of sand and fines (**Table 1**), rather than larger substrate classes such as coarse gravel and cobble, which are preferred substrates for white sturgeon spawning (Shaffter 1997, Parsley and Beckman 1994). However, in 1973, Kohlhurst (1976) documented white sturgeon spawning just upstream of the mouth of the Feather River at river kilometer (rkm) 129, where bottom substrate consists of fine to medium sands. White sturgeon spawning in the San Joaquin River was documented in reaches where sand is the dominant substrate (Jackson et. al 2012).

No sturgeon eggs were collected during the 2017 Sacramento River sturgeon spawning egg mat pilot study. No sturgeon aggregations were observed during DIDSON surveys conducted for site substrate evaluation, and no sturgeon were observed breaching in the study reaches during egg mat deployment and retrieval efforts. No other fish eggs were observed on the egg mats. Several unidentified lamprey microphthalmia were collected from egg mats deployed at Site 8. Benthic macroinvertebrates including caddisfly larvae (Hydropsychidae), mayfly larvae (Baetidae, Heptageniidae), and clams (*Corbicula fluminea*) were commonly observed on the egg mats during inspections. Debris loads (e.g., vegetation, fine substrate) on egg mats ranged from light to heavy. Although heavy debris loads, particularly cocklebur seeds, made for more time-consuming mat inspections, detection of any sturgeon eggs attached to the mats or seeds would still have been possible.

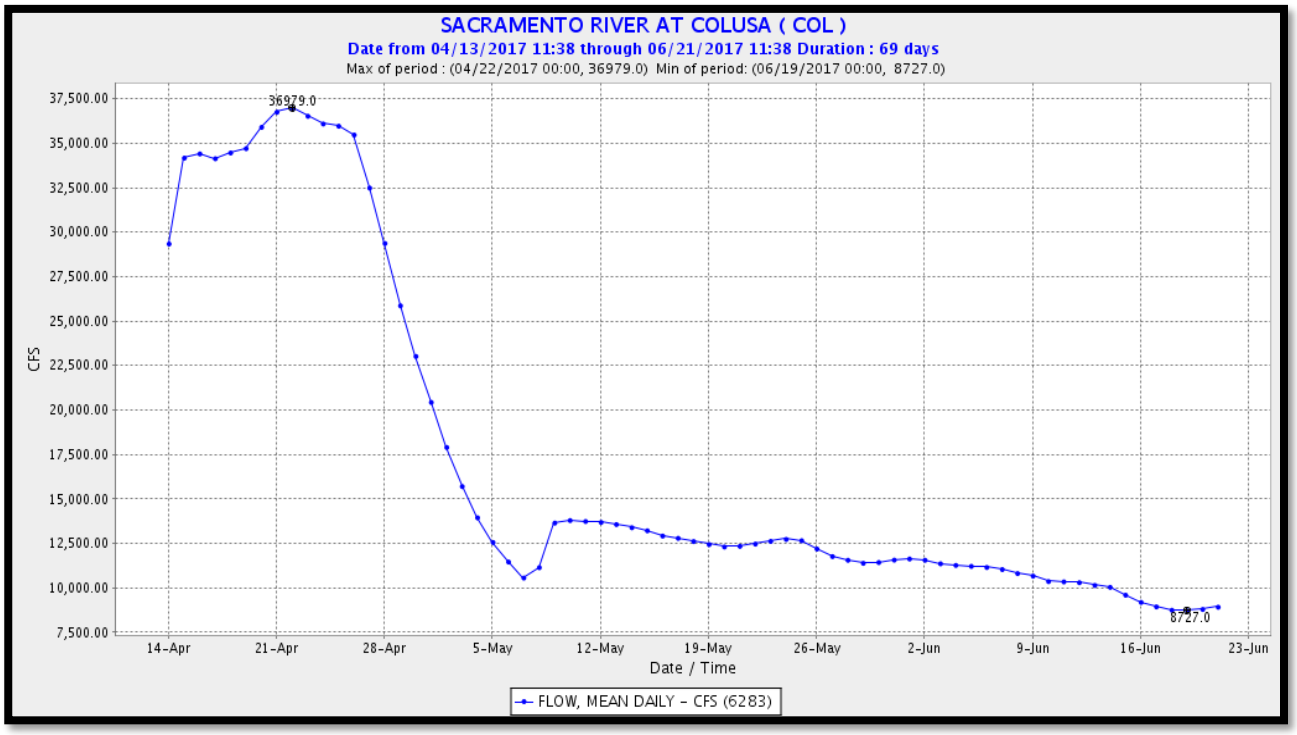

Figure 3. Sacramento River flows, 13 April through 21 June 2017.

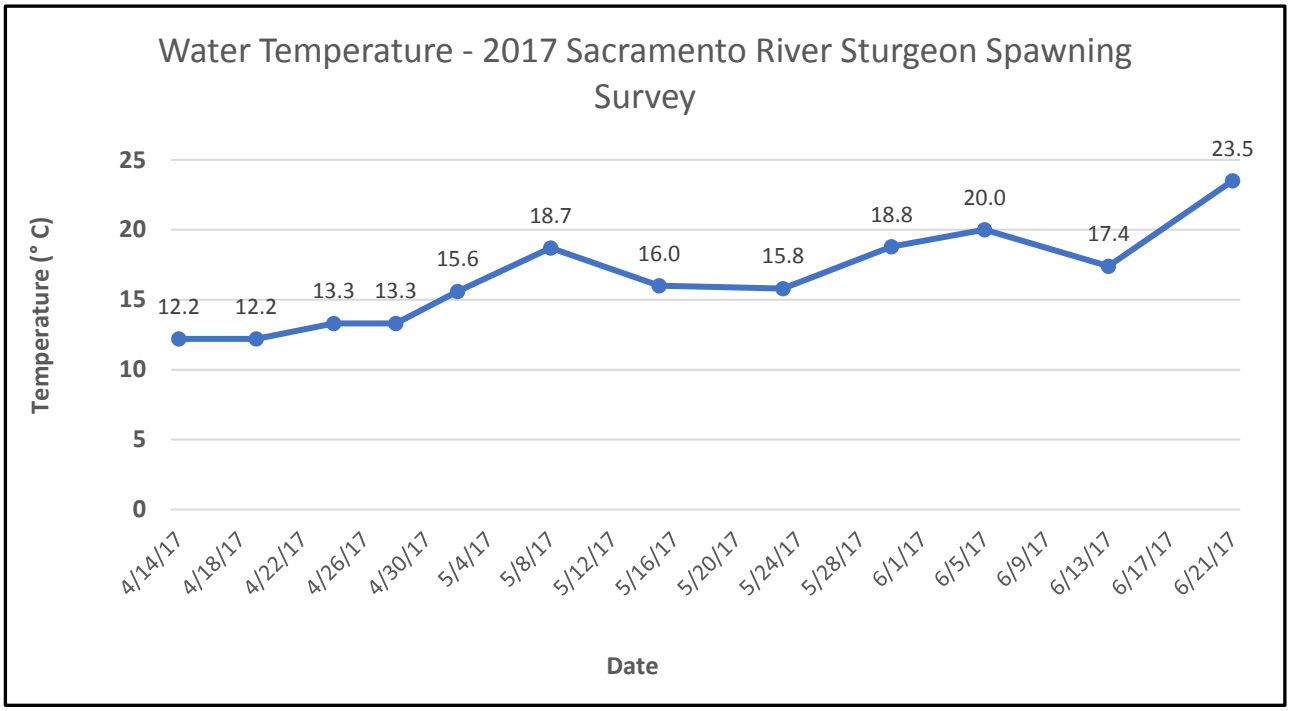

Figure 4. Sacramento River water temperatures, 14 April 2017 through 21 June 2017.

Table 1. Deployment, retrieval, and total deployment times; and environmental data for Sacramento River sturgeon spawning sampling sites, 14 April 2017 through 21 June 2017.

Site/Mat	Latitude	Longitude	Deployment Dates	Retrieval Dates	Total Days Fished	Initial Depth (m)	Substrate	Initial Estimated Flow Velocity (mps)
1/1	38°50.414	121°43.657	4/14	Missing	N/A	7.9	Sand; fines	1
1/2	38°50.532	121°43.598	4/14, 4/19, 4/24	4/19, 4/24	8	9.8	Sand; fines	1
2/1	38°51.143	121°43.426	4/14, 4/19, 4/24	4/19, 4/24	8	6.4	Sand; fines	1
3/1	38°52.520	121°44.864	4/14, 4/19, 4/24	4/19, 4/24	8	7.6	Sand; fines	1.3
4/1	38°52.145	121°45.416	4/14, 4/19, 4/24	4/19, 4/24	8	8.5	Sand; fines	1
4/2	38°52.095	121°45.582	4/14, 4/19, 4/24	4/19, 4/24	8	9.8	Sand; fines	1
5/1	38°51.978	121°47.651	4/24, 4/28, 5/2	4/28, 5/2, 5/8	14	6.7	Cobble; sand	1.3
5/2	38°51.978	121°47.651	4/24, 4/28, 5/2	4/28, 5/2, 5/8	14	9.2	Sand; fines	1.3
6/1	38°54.053	121°48.202	4/28, 5/2	4/28, 5/2, 5/8	14	4.3	Sand; fines	1.3
7/1	38°54.673	121°48.294	5/15, 5/18, 5/30, 6/5, 6/13	5/18, 5/23, 5/30, 6/5, 6/13, 6/21	37	7.9	Sand; fines	0.7
7/2	38°54.624	121°48.388	5/15, 5/18, 5/30, 6/5, 6/13	5/18, 5/23, 5/30, 6/5, 6/13, 6/21	37	8.5	Sand; fines	0.7
7/3	38°54.609	121°48.483	5/15, 5/18	5/18, 5/23	8	7.6	Sand; fines	0.7
8/1	38°57.14"	121°50.23"	5/23, 5/30, 6/5, 6/13	5/30, 6/5, 6/13, 6/21	29	11.0	Sand; fines	0.7
8/2	38°57.14"	121°50.23"	5/23, 5/30, 6/5, 6/13	5/30, 6/5, 6/13, 6/21	29	11.6	Sand; fines	0.7
9/1	38°58.415"	121°49.385	6/13	6/21	8	7.3	Sand; fines	0.7

Discussion

Although no sturgeon eggs were collected during the pilot study and therefore white sturgeon spawning events could not be documented in the study reach, CDFW staff gained experience that will provide a basis for further studies. There are several explanations as to why white sturgeon spawning was not detected in the study reach. It is possible that white sturgeon spawning occurred in the study reaches prior to study initiation. White sturgeon spawning in the Sacramento River may occur as early as mid-February (Kohlhorst 1976). The Sacramento River white sturgeon spawning study was not initiated until 14 April 2017, as prioritization of Yolo Bypass fish rescue operations resulted in postponement of the study initiation by over a month. Capture of sturgeon larvae was reported in the 20-mm midwater trawl Delta smelt larval monitoring survey in the lower Sacramento River at Threemile Slough during the first week of March 2017 and in the San Francisco Bay Study otter trawl survey in the third week of March (CDFW 2017). White sturgeon eggs are reported to hatch at 152 to 200 hours (6.3 days to 8.3 days) at 15.7° C (Deng *et. al.* 2002). Wang et. al. (1985) reported that time to hatch is dependent on temperature but larvae generally hatch in 4-12 days. Although the Sacramento River water temperature was 12.2° C at the study initiation and likely several degrees below this in late February through early March, the cooler water temperatures would likely not delay egg hatch by more than a few days. High Sacramento River flows during early March could have swept any newly hatched sturgeon larvae in the study reach downstream to the upper Delta where they were detected in the aforementioned surveys. Another explanation as to why the pilot study was not successful in documenting sturgeon spawning in the study reach is that spawning may have occurred downstream or upstream of the study sites. In years of high winter or early spring outflows, white sturgeon are thought to spawn in lower reaches of the Sacramento River (e.g., downstream of Verona) (personal communication with Joe Heublein, NMFS). However, Cramer Fish Sciences deployed egg mats at several sites downstream of Knights Landing prior to initiation of the CDFW study, however; they did not report collection of sturgeon eggs at these sites. Cramer Fish Sciences also deployed egg mats at several sites upstream of Colusa, and they reported collecting 47 white sturgeon eggs from an egg mat deployed at Hamilton Bend on 11 April 2017, therefore; it appears that at least some white sturgeon spawned upstream of Colusa.

Recommendations

More intensive reconnaissance surveys for sturgeon aggregations should be conducted beginning in mid to late-January to determine timing of egg mat deployments. If sturgeon aggregations are not detected at sites include in the 2017 pilot study, the survey should be expanded to include sites in the Colusa and Hamilton Bend reaches. DIDSON surveys used to detect sturgeon aggregations were of limited success. Deployment of the DIDSON camera via the hand-held, pole mount was difficult as swift currents made it difficult to hold and pan the camera over potential holding areas. One option to overcome this obstacle is to deploy a DIDSON camera via a boat-mounted platform to stabilize the camera while evaluating swift water riverine habitat. Another option is to use a new generation sonar fish-finder. The use of side-scan sonar units has also been shown to be an effective method for identifying sturgeon holding near the bottom of large rivers and estuaries. One CDFW Anadromous Fisheries vessel is now equipped

with a recreational-grade side-scan sonar unit that is capable of marking sturgeon and also determining differences in substrate composition.

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