

Telemetric Monitoring of Juvenile Southern Distinct Population Segment of the North American Green Sturgeon (*Acipenser medirostris*) on the Lower Sacramento River and Sacramento-San Joaquin Delta

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Abstract

Currently there is very little known about rearing, migratory behavior, and general emigration patterns of juvenile southern Distinct Population Segment (sDPS) North American green sturgeon (*Acipenser medirostris*) and white sturgeon (*Acipenser transmontanus*) within the Lower Sacramento River, Sacramento-San Joaquin Delta (Delta), and San Francisco Bay (Thomas et al. 2015). These data are crucial for improved species management in California's Central Valley. To better understand emigration, California Department of Fish and Wildlife (CDFW) is undertaking a collaborative effort with University of California Davis Biotelemetry Laboratory (UCDBL) and U.S. Fish and Wildlife Service, Red Bluff (USFWS) to capture and acoustically tag up to 100 green sturgeon and 100 white sturgeon per year for three years. Telemetry data from all years will be compiled and analyzed for differences in water year-type rearing and migratory behavior.

Sampling is conducted by deploying and tending two 30.5-m (100-ft) variable mesh gill nets anchored with 18-kg (40-lb) pyramid weights. Juvenile sturgeons are surgically implanted with Vemco® V9 69 kHz acoustic transmitters and released near the point of capture. An array of Vemco® acoustic receivers deployed throughout the lower Sacramento River, Delta, and San Francisco Bay collects detection data for acoustically tagged juvenile sturgeons. Year one sampling was conducted at nine different sites in the Delta. To date, six juvenile Green Sturgeon and six juvenile White Sturgeon were tagged in 500 hours of sampling effort. Based on the extremely low catch per unit effort (CPUE), year one results suggest recruitment during consecutive critically dry water years may be low. With a nearly normal precipitation year and corresponding higher outflow, it is hoped that juvenile recruitment and CPUE will increase in years two and three of the study.

Background and Objectives

The southern Distinct Population Segment (sDPS) North American Green Sturgeon population was listed as threatened on 7 April 2006 (71 FR 17757). SDPS Green Sturgeon spawn in the Sacramento River from river kilometer (rkm) 426 downstream to rkm 332.5 (Poytress et al. 2011; Brown 2007) and were recently documented spawning in the Feather River, a major tributary to the Sacramento River (Seeholtz et al. 2014). Juvenile sDPS Green Sturgeon are thought to rear for up to three years throughout the lower Sacramento River, Delta, and San Francisco Bay before emigrating to the Pacific Ocean, although there is little information on specific movement and emigration patterns

of young-of-year (YOY) and yearling sDPS North American Green Sturgeon and White Sturgeon for these locations (Thomas et al. 2015; Moyle 2002). In early 2014, Governor Brown issued a state of emergency proclamation due to prolonged drought conditions that directed the CDFW to evaluate and manage drought-related impacts on threatened and endangered species and conduct specific monitoring actions described in the State and Federal Drought Operations Plan. The lack of information on juvenile sDPS Green Sturgeon migration timing, survival, and transition rates throughout the lower river and bay/delta region is problematic from a species management perspective and necessary for understanding drought effects and managing increased drought-related risks. The purpose of this study is to document spatial and temporal emigration patterns and rearing habitat preferences for juvenile sturgeon in the Sacramento River, Delta, and San Francisco Bay. In this collaborative effort between CDFW, UCDBL, and USFWS, we are attempting to capture and acoustically tag up to 100 sDPS juvenile Green Sturgeon and 100 juvenile White Sturgeon over the next three years and track their spatial and temporal movement patterns using biotelemetry.

Methods

Sampling was conducted by deploying two-three 30.5 meter (100 foot) variable mesh gill nets each consisting of 10.1-cm, 7.6-cm, and 7.0-cm (4-inch, 3-inch, and 2.75-inch) mesh panels anchored with 18-kg (40-lb) pyramid weights affixed to the ends of the lead line. Gill nets are an effective method for capturing juvenile sDPS Green Sturgeon in the Delta (Radke 1966). Sampling site locations were selected based on historical juvenile sturgeon capture locations, channel width, depth, bottom contour, benthic macroinvertebrate production, submerged vegetation, tidal phase, and current velocity (Figure 1).

Net soak times ranged from 60 to 240 minutes and were dictated by water temperature and dissolved oxygen levels as specified in National Marine Fisheries Service (NMFS) Endangered Species Act (ESA) Section 10 Permit 17551. During initial phases of sampling, nets were checked for entrained sturgeon using adaptive resolution imaging sonar (ARIS; Sound Metrics Corporation). CPUE was calculated as the number of juvenile sturgeon captured per hour of set time. Sampling data including site location, depth, capture time, tidal phase, and water temperature were routinely analyzed to optimize capture efficiency (Table 1). Captured juvenile sDPS Green Sturgeon and White Sturgeon were surgically implanted with Vemco® V9 69 kHz acoustic transmitters and released near the point of capture (Figure 2). An array of Vemco® 69 kHz real-time and autonomous acoustic receivers deployed throughout the lower Sacramento River and Delta and maintained by UCDBL provide detection data for acoustically tagged juvenile sturgeon.

Results

Greatest sampling effort to date has been the Sacramento River downstream of Rio Vista, and during the first year of the study sampling was conducted throughout the calendar year. To date, six juvenile sDPS Green Sturgeon and seven juvenile White Sturgeon were captured in 504 hours of effort since the initiation of sampling on 21 July

2015. Total CPUE was 0.012 per hour for juvenile Green Sturgeon and 0.014 per hour for juvenile White Sturgeon (Table 2). To date, juvenile Green Sturgeon were captured during the months of July and September; while juvenile White Sturgeon were captured from May through September (Figure 3). CPUE was highest at Site 6 (five Green Sturgeon and six White Sturgeon) and Site 3 (one Green Sturgeon and one White Sturgeon). Sampling effort by site ranged from 4.2 hours at Site 9 to 183.5 hours at Site 6. All sturgeon were captured at net set depths ranging from four to eight meters (13 to 26 feet). Most juvenile sturgeon were captured on days with relatively small tidal changes (e.g., less than one meter height difference between low and high tide) and during slack or nearly slack current. Detection records for GS15-01, tagged 24 September 2015, are shown in Figure 4. Data from the receiver array during the summer months of 2016 are being analyzed.

Discussion

Pilot year efforts at capturing and acoustically tagging juvenile sturgeon were successful through CPUE was lower than anticipated. Food abundance may be a factor influencing CPUE. Although not quantified, Site 6 had a noticeably greater abundance of *Corophium* sp. amphipods than all other sites sampled and sturgeon captures appeared to coincide with seasonal peaks in *Corophium* sp. abundance. *Corophium* sp. is a major prey item of both juvenile Green and White Sturgeon (Radke 1966).

Water year type may also be a factor in spawning success of sDPS Green Sturgeon and recruitment of juveniles in the lower Sacramento River and Delta. Abundance indices of young-of-year white sturgeon in the Bay Study Otter Trawl were zero for 13 of 17 dry or critically dry years and zero for only 5 of 19 below normal, normal, or wet years between 1980 and 2015 (CDFW 2015 unpublished data). If recruitment of juvenile sDPS Green Sturgeon is similar to White Sturgeon, abundance of YOY and yearling sDPS green sturgeon in 2014 and 2015 (both critically dry years) may have resulted in extremely low numbers of fish present in the Delta during the sampling period.

Based on growth rates reported by Moyle (2002), the juvenile Green Sturgeon captured on 24 September 2015 is likely a one-year old individual; all other juvenile Green Sturgeon tagged were likely between three and five years old. Juvenile Green Sturgeon are thought emigrate to the Pacific Ocean between one and three years' of age; Green Sturgeon between 70 and 120 total length are thought to be marine (Moyle 2002). The capture of five Green Sturgeon of at least three years' of age may indicate that some individuals are rearing in the Delta for longer than three years; or possibly making seasonal migrations from marine habitat back to the lower Sacramento River. To increase encounter rates with juvenile sturgeon in years two and three of the study we are incorporating additional sampling methods. NMFS ESA Section 10 Permit 17551 amendments were requested and recently authorized to include additional sampling methods (e.g., otter trawls, set lines), as well as tagging of juvenile sDPS Green Sturgeon encountered as bycatch in other fisheries monitoring programs.

References

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Figure 1. Juvenile sturgeon sampling sites



Figure 2. Juvenile green sturgeon captured 12 July 2016 on surgery table and ready for acoustic tag implantation



Table 1. Capture data for juvenile sturgeon tagged in the lower Sacramento River, 24 September 2015 to 13, September 2016

Species	Fork/Total Length (cm)	Capture Date	Capture Time	Capture Location	Net Depth (m)	Tide Phase	Water temperature (°C)
Green sturgeon	33/37	24-Sep-15	14:35	Site 6	4.3-7.3	Beginning of ebb	21.4
White sturgeon	64/73	18-May-16	12:53	Site 6	5.2-6.7	Middle of flood	20.1
White sturgeon	65/75	16-Jun-16	10:50	Site 3	4.9	Beginning of ebb	20.4
Green sturgeon	82/94	12-Jul-16	10:40	Site 6	4.3-7.3	Beginning of flood	20.5
Green sturgeon	59/64	12-Jul-16	13:25	Site 6	5.2-7.3	Beginning of ebb	21.5
White sturgeon	25/29	13-Jul-16	13:15	Site 3	4.6	Beginning of ebb	21.5
Green sturgeon	62/70	14-Jul-16	10:47	Site 3	4.6-4.9	Beginning of flood	21.5
Green sturgeon	74/81	26-Jul-16	12:50	Site 6	4.9-7.3	Beginning of ebb	22
White sturgeon	29/35	24-Aug-16	11:07	Site 6	4.9-7.6	Beginning of ebb	20.2
White sturgeon	33/37	8-Sep-16	11:06	Site 6	4.0-6.7	Beginning of flood	20.9
White sturgeon	35/41	8-Sep-16	13:44	Site 6	5.8-7.9	End of flood	20.9
Green sturgeon	80/91	8-Sep-16	14:32	Site 6	4.9-7.0	End of flood	20.9
White sturgeon	33/38	13-Sep-16	13:03	Site 6	4.9-7.3	Middle of flood	19.6

Table 2. CPUE by site for juvenile sturgeon, lower Sacramento River and Delta, July 2015 through September 2016

Site	Total Hours	Green Sturgeon CPUE	White Sturgeon CPUE
1	12.2	0	0
2	57.7	0	0
3	23.8	0.042	0.042
4	8.8	0	0
5	25.4	0	0
6	183.5	0.027	0.033
7	163.8	0	0
8	18.4	0	0
9	4.2	0	0
10	6.2	0	0

Figure 3. Capture by month for juvenile sturgeon, lower Sacramento River and Delta, July 2015 through September 2016

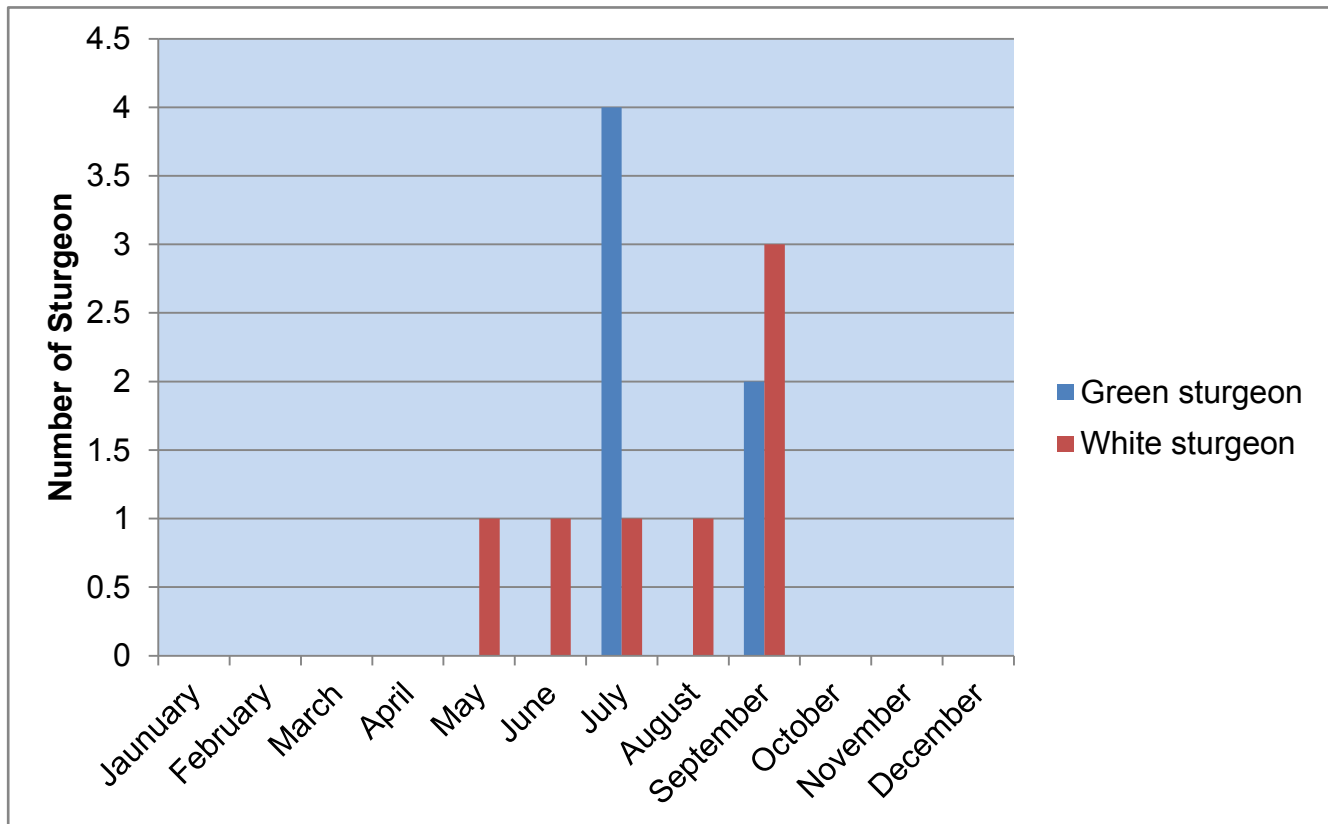


Figure 4. River kilometer (rkm) plot of detection records for juvenile green sturgeon GS15-01 tagged at rkm 86 (near Decker Island) on 24 Sept, 2015. Note the extended detection history near rkm 97 (Rio Vista Bridge) and the last detection, likely indicating ocean entry at rkm 14 (Richmond Bridge)

