Movements of adult and sub-adult green sturgeon (*Acipenser medirostris*) in the San Francisco Estuary

John T. Kelly[1], A. Peter Klimley[1] and Carlos E.Crocker[2]

[1]Department of Wildlife, Fish, & Conservation Biology, University of California, Davis

[2]Department of Biology, San Francisco State University

Introduction

The green sturgeon (*Acipenser medirostris*) is a long-lived, iteroparous, anadromous, native fish that occurs in low numbers in the San Francisco Estuary. Adults spawn in freshwater rivers in Oregon and California including the Sacramento River (Moyle et al. 1995). Larvae develop within these freshwater systems, and remain in the estuaries for between one and four years before migrating to the ocean (Beamesderfer & Webb 2002). Mature adults move into estuaries in the spring, and spawning adults continue into natal rivers in late spring/early summer. Post spawning adults return to the estuary, before migrating back to the ocean in late fall. Sub-adult fish also are thought to enter estuaries during summer and fall months.

There is little published information about green sturgeon distribution within the San Francisco Estuary and what, if any, physical parameters (e.g. temp, dissolved oxygen (DO), salinity) influence their movements. This poster presents the preliminary results from our field telemetry research.

Methods

Green sturgeon were captured by trammel net in San Pablo Bay. Fish were surgically implanted with depth sensing ultrasonic transmitters (Vemco V22XP), and manually tracked for 2-16 hours a day over periods ranging from 1-12 days. At hourly intervals during each track, the salinity, temperature, and DO profiles of the water column were sampled to a maximum depth of 25 m with a Hydrolab Surveyor II.

Results

Five sub-adult and one adult fish (gender unknown) were tracked in the San Francisco Estuary between during the fall months of 2001 and 2002 (Fig. 1). Movements can be categorized as either "milling" or directed, with the former observed more frequently, accounting for 60.8% of observations. When "milling" (e.g. Fig. 1:GS6) fish were observed to remain on or near the bottom (Fig. 2), moving slowly or even not at all (Fig. 4) and making frequent changes in direction (Fig. 5a). Directed movements (e.g. Fig. 1:GS5) were typified by continuous and active swimming (Fig. 4) near the surface (Fig. 3) while holding a steady course for many consecutive hours (Fig.5b). The fish were typically observed to move in the same direction as the prevailing current, though swimming actively. Green sturgeon ranged widely across physical parameters, and were found at depths of between 0.7 m and in excess of 15 m, temperatures between 14.5-20.8 °C, salinities between 8.8-32.1 ppt, and DO contents between 6.5-9.0 mgO_2/L (see Fig. 7a-c for summary histograms). Thus far, activity appears to be independent of light level with no discernable crepuscular, nocturnal, or diurnal changes in movement (data not shown).

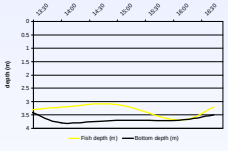

Fig. 2. Depth record for GS6 (10/28/02) illustrating the benthic orientation observed during "milling."

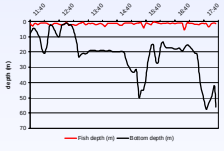

Fig. 3. Depth record for GS5 (10/22/02) illustrating surface oriented swimming observed during directed movement.

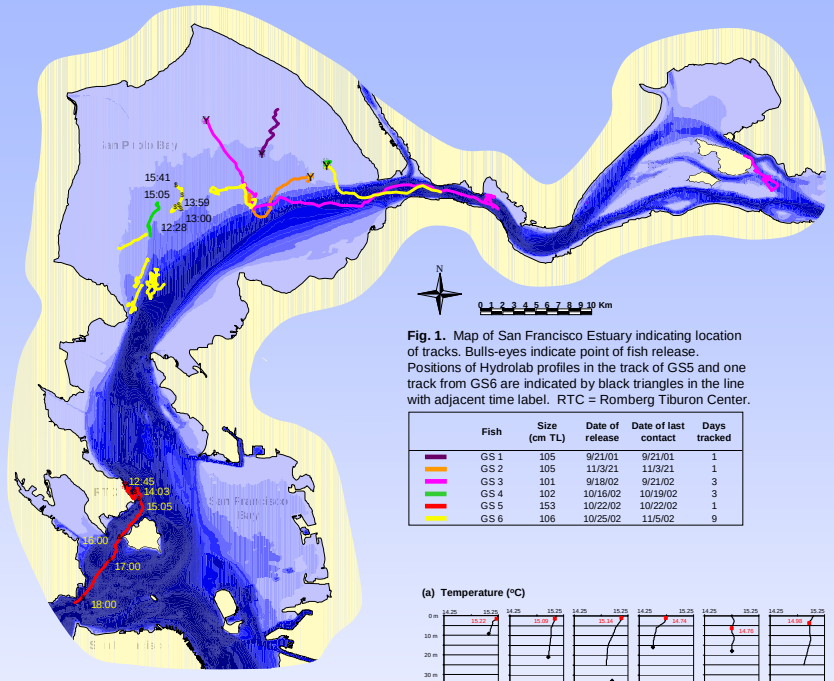

Fig. 1. Map of San Francisco Estuary indicating location of tracks. Bulls-eyes indicate point of fish release. Positions of Hydrolab profiles in the track of GS5 and one track from GS6 are indicated by black triangles in the line with adjacent time label. RTC = Romberg Tiburon Center.

Fish	Size (cm TL)	Date of release	Date of last contact	Days tracked
GS 1	105	9/21/01	9/21/01	1
GS 2	105	11/3/21	11/3/21	1
GS 3	101	9/18/02	9/21/02	3
GS 4	102	10/16/02	10/19/02	3
GS 5	153	10/22/02	10/22/02	1
GS 6	106	10/25/02	11/5/02	9

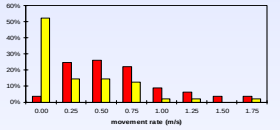

Fig. 4. Comparison of frequency of rates of movement (m/s) exhibited by GS6 (yellow bars) during a typical "milling" behavior and GS5 (red bars) during directed movement. "Milling" is typified by slow movements with frequent stops, whereas fish making directed movements rarely stop and are more active.

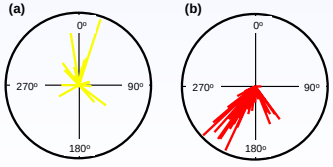

Fig. 5 (a-b). Vector distributions (5 min. intervals) of milling (a – GS6) and directed (b – GS5) movements. Note the concentration of movement vectors in (b).

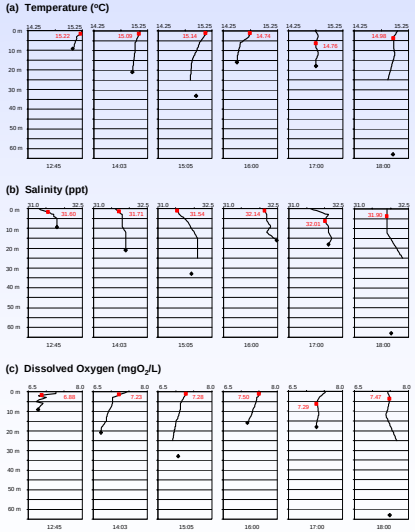

Fig. 6 (a-c). Example of hourly water column profiles recorded during a single track (see Fig. 1: GS5). Black line = measured data, black diamond = bottom depth, red square = fish depth. Note the narrow range of each profile, the variability between successive profiles, and the lack of well defined water layer stratification.

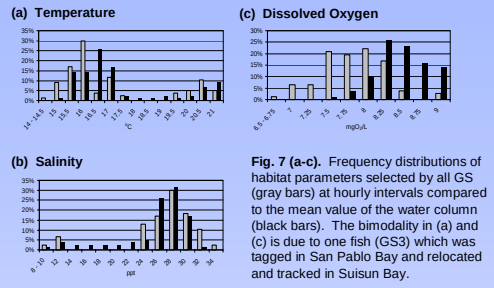

Fig. 7 (a-c). Frequency distributions of habitat parameters selected by all GS (gray bars) at hourly intervals compared to the mean value of the water column (black bars). The bimodality in (a) and (c) is due to one fish (GS3) which was tagged in San Pablo Bay and relocated and tracked in Suisun Bay.

Discussion

Green sturgeon make use of much of the San Francisco Estuary, and occasionally make significant large scale movements throughout the region. At the start of the project, it was assumed that these movements would be influenced by physical parameters such as temperature, salinity, and DO with the fish seeking preferred conditions. However, as can be seen in Fig. 6(a-c), the estuary is vertically well mixed with no apparent pattern to sturgeon preferences. When the conditions experienced by the fish at the time of each Hydrolab profile are compared to the mean values of the water column at that time (Fig. 7 (a-b)) it is apparent that sturgeon movements are no different than would be expected if they were moving at random. There was no difference between fish and mean column values for either temperature or salinity. A difference was detected in DO preference (Fig. 7c); however, it is believed that this is an artifact of the large number of data points during which the fish were motionless on the bottom, rather than a preference for low environmental DO. It is possible that different results may be found in a more stratified system.

Green sturgeon clearly move for some reason, shifting from localized "milling" to large scale directed movements. We do not know what the fish were doing while "milling" but foraging is likely. Reasons for directed movements likely vary with both maturity of the fish and time of year. Movements by sub-adults (e.g. Fig. 1:GS3) and pre and post spawn adults may be related to ranging between foraging sites, while late season movements such as that exhibited by GS5 (Fig. 1) are likely the initiation of migratory behavior.

Literature Cited

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Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish species of Special Concern in California, 2nd edition. Final Report to the Department of Fish and Game.

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For more information, contact the author at jtkelly@ucdavis.edu