

Green Sturgeon Feeding Observations in Humboldt Bay, California

Matt Goldsworthy¹, Bill Pinnix², Miles Barker¹, Liz Perkins¹, Aaron David², Jeffrey Jahn¹

Introduction

Understanding the distribution, habitat use, and feeding habits of Green Sturgeon (*Acipenser medirostris*) is important to inform analyses of the potential effects to individual fish as well as to the rearing and migration functions of their critical habitat. Increasing our understanding of Green Sturgeon behaviors will also help identify conservation measures for projects in Humboldt Bay to reduce potential effects. During past studies of tagged juvenile Coho Salmon in 2006/2007, Bill Pinnix observed numerous (~30 tagged individuals per year) Green Sturgeon in the northern portion of the Arcata Channel (North Bay) and elsewhere throughout the bay. In order to learn more about the potential significance of Green Sturgeon use of North Bay, United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) staff visited the area in North Bay where most of the detections of Green Sturgeon occurred during the 2006/2007 studies.

Methods

We departed on the USFWS's R/V *Alcid* from Woodley Island at 0740 on August 19, 2016, during a low tide and headed towards the northern reaches of the Arcata Channel, located in the North Bay area of Humboldt Bay. USFWS employed a directional acoustic receiver (VEMCO VR28) in order to detect any acoustically tagged individuals and identify the general location or direction of the detected individuals in relation to the R/V. The R/V was positioned in the target area and then drifted down the channel with the outgoing tide for two separate drifts, each about one hour in duration. The general location, number, and context of Green Sturgeon breaching behaviors were recorded as were data available from individuals detected with the acoustic receivers.

Results

Drift 1: Immediately upon arrival to the target area in the northern reaches of the Arcata Channel, we began observing Green Sturgeon jump into the air in a vertical position with their bodies completely out of the water. Between 0800 and 0845, we recorded over 10 individual jumps or breaches of Green Sturgeon while the boat drifted in a southwest (downstream) direction down the Arcata Channel with the tide. While we drifted down the Arcata Channel, the USFWS (VEMCO VR28) receivers also detected >3 acoustically tagged Green Sturgeon.

¹ Matt Goldsworthy, Liz Perkins, Miles Barker, and Jeffrey Jahn: National Marine Fisheries Service, Northern California Office, Arcata, CA 95521. (707) 822-7201

² Bill Pinnix and Aaron David: United States Fish and Wildlife Service, Arcata Field Office, California 95521. (707) 822-7201

Field Note

Although multiple individual tags were heard on the receiver, only 2 tags were decoded (Table 2); the VEMCO VR28 receiver is an older model that is unable to decode acoustic tags released in recent years. Around 0845, the activity slowed as we had drifted down the channel a considerable distance. All ten of the breaching observations occurred in between GS1 and GS4 (see Figure 1). Northern Anchovies (*Engraulis mordax*) were observed fleeing along the surface and jumping throughout the entire drift.

Drift 2: We started our second drift at 0905, and at 0909 the USFWS receivers began detecting acoustically tagged fish (Table 2). At 0915, Green Sturgeon breaching activity resumed and between 0915 and 1017, we observed 23 instances of Green Sturgeon jumping or breaching out of the water. Northern Anchovies were observed in high numbers fleeing along the surface of the water throughout the drift.

Discussion

When combined, our observations between 0800 and 1017h total 33 instances of Green Sturgeon jumping or breaching above the surface of the water (one breach or jump occurring approximately every 4-minutes during our visit, see Table 1), with several detections of Green Sturgeon recorded on the USFWS directional radio receiver (Table 2).

TABLE 1: Number of breaches of Green Sturgeon observed during Drift 1 (between 0800 and 0845h) and Drift 2 (between 0905 and 1017h) in North Bay, August 19, 2016.

General Area	# Breaches Drift 1	# Breaches Drift 2
GS1	10	2
GS2		11
GS3		2
GS4		6
GS5		2
TOTAL	10	23

TABLE 2: Detections of acoustically tagged Green Sturgeon made by USFWS directional acoustic receiver (VEMCO VR28).

Tag Code	Tagging Origin	Comment
A69-1303-20488	Sacramento River	Adjacent to oyster bed. R/V at GS2. Fish tagged in 2011
A69-1105-55	Sacramento River	In small channel. R/V at GS2. Fish tagged in 2011

Likely Observations of Green Sturgeon Pelagic Feeding

At 0955, a Green Sturgeon was observed next to the boat in a position that suggests it was feeding. The caudal fin and posterior portion of the body were completely out of the water, indicating the fish was at a diagonal angle. The caudal fin was moving wildly above the surface of the water while the fish remained at a diagonal angle. This type of behavior and body position (diagonal angle of body) is known to be exhibited by Green Sturgeon while feeding (Moser 2016). Based on the very high abundance of Northern Anchovies in the area, it appears this individual may have been attempting to feed on Northern Anchovies approximately 1-2 meters below the water's surface. Northern Anchovies were abundant in the area and were displaying avoidance behaviors such as jumping and fleeing along the surface of the water. In most cases, Northern Anchovies were observed jumping or fleeing immediately before Green Sturgeon breaching behaviors occurred. Although not confirmed, it appears that Green Sturgeon were feeding on Northern Anchovies based on these observations. Beamesderfer and Farr (1997) reported that pursuit and capture of active prey contradicts the image of sturgeon as merely sluggish bottom scavengers.

Previous studies have confirmed that Northern Anchovy are a component of the Green Sturgeon diet (Moyle *et al.* 1995), although most research (Patten and Norelius 2016, Moser *et al. in press*, Dumbauld *et al.* 2008) suggests that Green Sturgeon prefer other prey resources over Northern Anchovy. Northern Anchovies are not a benthic species, and given the ventral position of the sturgeon's mouth, it would seem that Northern Anchovies would not be an efficient prey item to pursue and consume for a large individual such as a Green Sturgeon. However, Muir *et al.* (1986) found that Northern Anchovy was the principal fish species consumed overall, and was the primary prey item for White Sturgeon >800 mm in the Columbia River estuary. Northern Anchovies accounted for the majority of the prey consumed by weight for all sizes of sturgeon and composed almost 75% of the diet (by weight) for the largest individuals sampled during the study (Muir *et al.* 1986).

The opportunistic feeding behavior of sturgeon that can be inferred from food habits studies suggests that these fish will prey on any suitable types of food items that are available in a particular area (Miller 2004). They are also likely to be able to utilize seasonally available food sources such as fish eggs or small fishes. Their powerful suction feeding mechanism gives them the ability to suck these food items rapidly into the mouth and allows them to feed opportunistically on any palatable prey that may be encountered (Miller 2004).

Given the high abundance of Northern Anchovies observed during our visit in Humboldt Bay; observations of avoidance behavior displayed by anchovies immediately prior to Green Sturgeon breaching behavior; Green Sturgeon feeding behavior observed near the surface of the water where anchovies were present; and the findings from Muir *et al.* (1986) documenting the importance of anchovy to the largest size classes of white sturgeon, it appears that Green Sturgeon were actively feeding on Northern Anchovies during our site visit on August 19, 2016.

Use of Higher Elevation (Intertidal) Areas and Aquaculture Infrastructure

At 1010 and 1016, acoustically tagged Green Sturgeon individuals were detected by the USFWS VEMCO VR28 directional receiver inside the small channel adjacent to an existing aquaculture bed (detections made from the R/V while at the GS2 location on the map- see Table 2). While it is unclear if these individuals were feeding within the aquaculture bed or immediately adjacent to the bed, it is clear that these individuals were using the smaller channel for migration or feeding purposes. Based on the data received and the direction of the detections, it is possible that one of these individuals was within the aquaculture bed (Sand Island North bed). Sturgeon have limited access to higher elevation areas, as these areas can be dry during low tides and accessible only during higher tides. Because access to these higher elevations of the intertidal zone is temporally limited, sturgeon access must be opportunistic and quick.

At 1017, the individual that was observed in the smaller channel at 1016 had swam past the boat and turned in a northerly direction and swam up into the smaller western channel (GS5). In a short amount of time (1-minute), an acoustically tagged individual moved from a smaller channel adjacent to an existing aquaculture bed and into the main Arcata Channel and then swam up the Arcata Channel and into a smaller channel (GS5 area on Figure 1). It appears that Green Sturgeon are frequenting higher elevation areas of the intertidal zone as evidenced by these observations. Furthermore, it is clear the movements can occur quickly, as one individual passed through three different channels in less than one minute of time.

Based on observations of Northern Anchovies fleeing onto higher elevations (and into eelgrass habitat) as the tide was rising, it appears Green Sturgeon might be pursuing anchovies into areas of higher elevation from the deeper channels as the tidal elevations provide enough depth for their access. If Green Sturgeon are predominantly feeding on anchovies in Humboldt Bay during portions of the summer, it is likely that sturgeon would follow anchovies as they seek cover from predation in eelgrass habitats or within the structure provided by shellfish aquaculture beds.

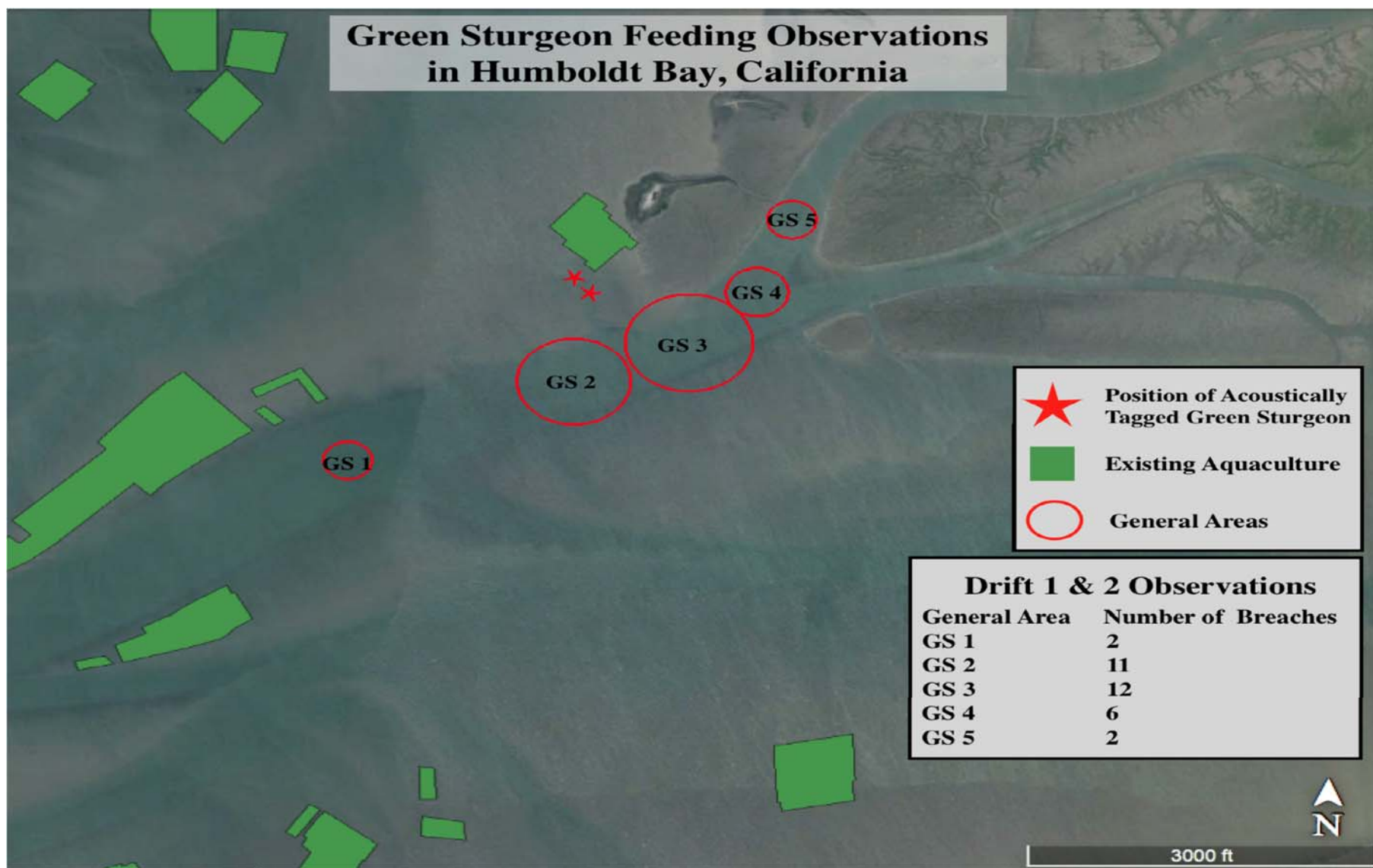


FIGURE 1: locations of Green Sturgeon observations in the North Bay of Humboldt Bay (Arcata Channel) from August 19, 2016.

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