**ATTACHMENTS**

*Note: All documents included here were provided in response to GGSA's August 25, 2011 Freedom of Information Act request to NMFS.*

# ATTACHMENT A

**Lower Feather River Sturgeon Information,**

**Compiled in July 2011**

**by**

Alicia Seesholtz
Department of Water Resources, Division of Environmental Services

The lower Feather River downstream of the Fish Barrier Dam (RKM 109) was designated critical habitat for the Southern Distinct Population Segment (sDPS) of the North American green sturgeon (green sturgeon) on October 9, 2009 (74 FR 52300). Therefore, determining how green sturgeon use the lower Feather River is important to the sDPS. While the Sacramento River is the only documented spawning area for green sturgeon, the lower Feather River may have the potential to provide a second spawning area. If green sturgeon do not spawn in the Feather River, it is important to understand if the system is being utilized as a holding or feeding area for adults that will later migrate and spawn in the Sacramento River. Understanding what benefits or detriments the lower Feather River provides to the sDPS of green sturgeon will provide valuable information for future management and enhancement of the system for the species.

While no formal research program is currently in place, a few short studies were conducted in the past before green sturgeon were listed for the FERC relicensing process of the Oroville Facilities and can be found at http://www.water.ca.gov/orovillerelicensing/wg-reports_EWG.cfm listed under Fisheries Reports SP-F3.2 Task 3A. In addition, ad hoc information has been accumulated by the Department of Water Resources over the last decade. Most of it has been anecdotal information or biologist observations. However, some sporadic field data is available.

Two green sturgeon tagged with VEMCO acoustic tags were detected in the river. The first was recorded at Beer Can Beach (River kilometer (Rkm) 14) from May 15-18, 2008. Discharge in this area was about 2100 cfs. The female left the system and was detected in the Sacramento River among the spawning grounds. On February 4, 2010, the second fish was detected at Star Bend (Rkm 29), stayed for several hours, and then it also migrated to the Sacramento River. Discharge in this area was about 2700 cfs. Previous studies suggested at least 5100 cfs was needed at Shanghai Bench in order for sturgeon passage (Seesholtz 2005). High flow events in early 2006 changed the bathymetry in this area that we now estimate it would require a discharge of about 5500 cfs to make Shanghai Bench passable for sturgeon upmigration.

While conducting DIDSON surveys this spring, an estimated 30-40 sturgeon were detected. At this point it is unknown what proportion of the sturgeon are green or white. One white sturgeon DWR identified was captured by an angler just upstream of the confluence with the Bear River (Rkm 21). All other sturgeon identified by DWR staff have been green sturgeon. One sturgeon was located with the DIDSON in the pool downstream of the Fish Barrier Dam (Rkm 108) in the Low Flow Channel (LFC) (Figure 1). Discharge in the LFC was as high as 12,000 cfs in March. It seems probable that other sturgeon also migrated this far upstream but headed back downstream as flows dropped to the base flow of 600 cfs. Approximately a dozen sturgeon

were recorded around the Thermalito Afterbay Outlet Pool (Rkm 95) (Figure 2). Another 20-25 sturgeon were located in the pool below Sunset Pumps (Rkm 61) which is downstream of the Oroville Facilities FERC Boundary about 25 river kilometers (Figure 3). Currently underwater video deployed in these areas to help determine species identification suggests the majority are green sturgeon; no whites have been identified with this method yet.

Figure 1. Sturgeon detected at Fish Barrier Dam Pool on April 14, 2011.

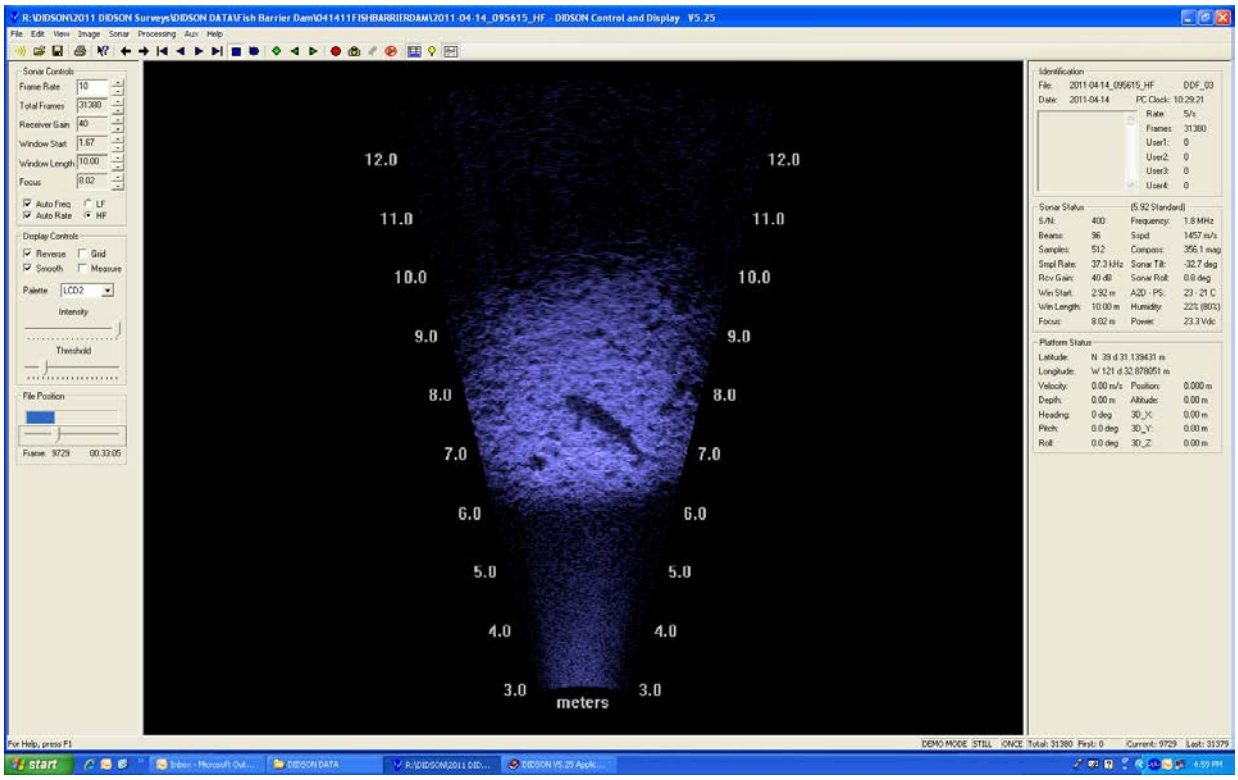


Figure 2. Sturgeon detected at Thermalito Afterbay Outlet Pool on April 11, 2011.

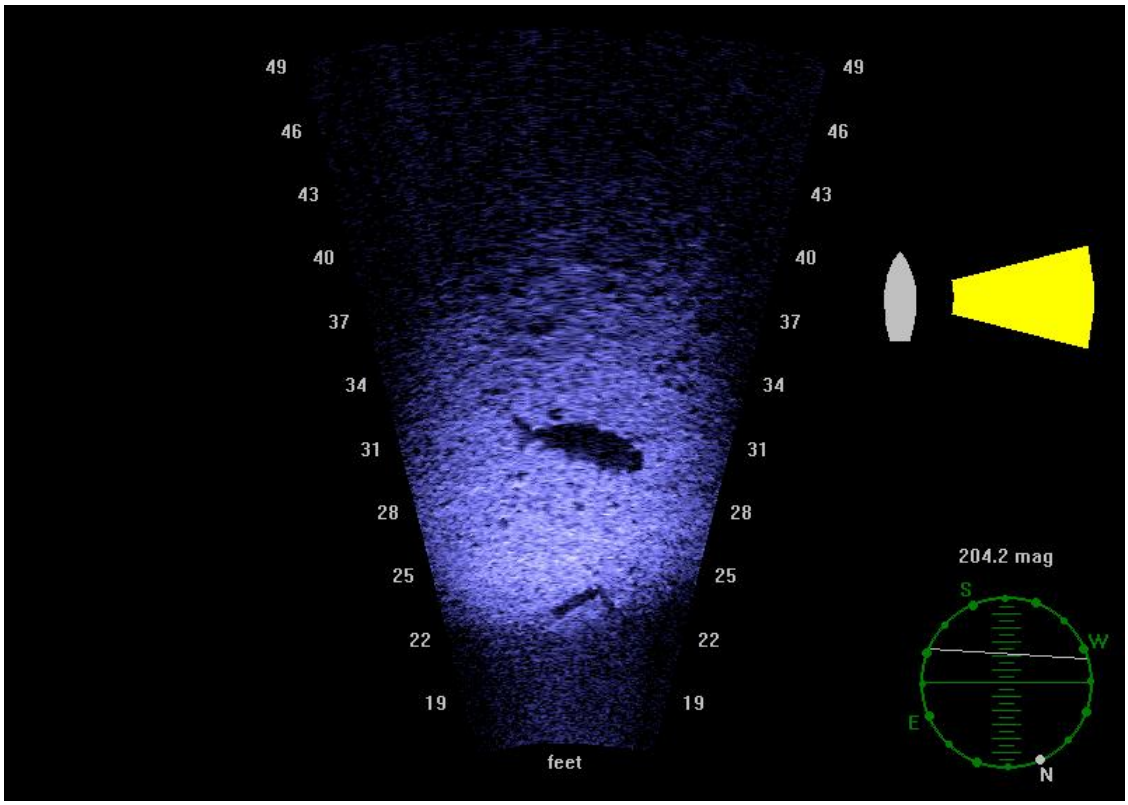
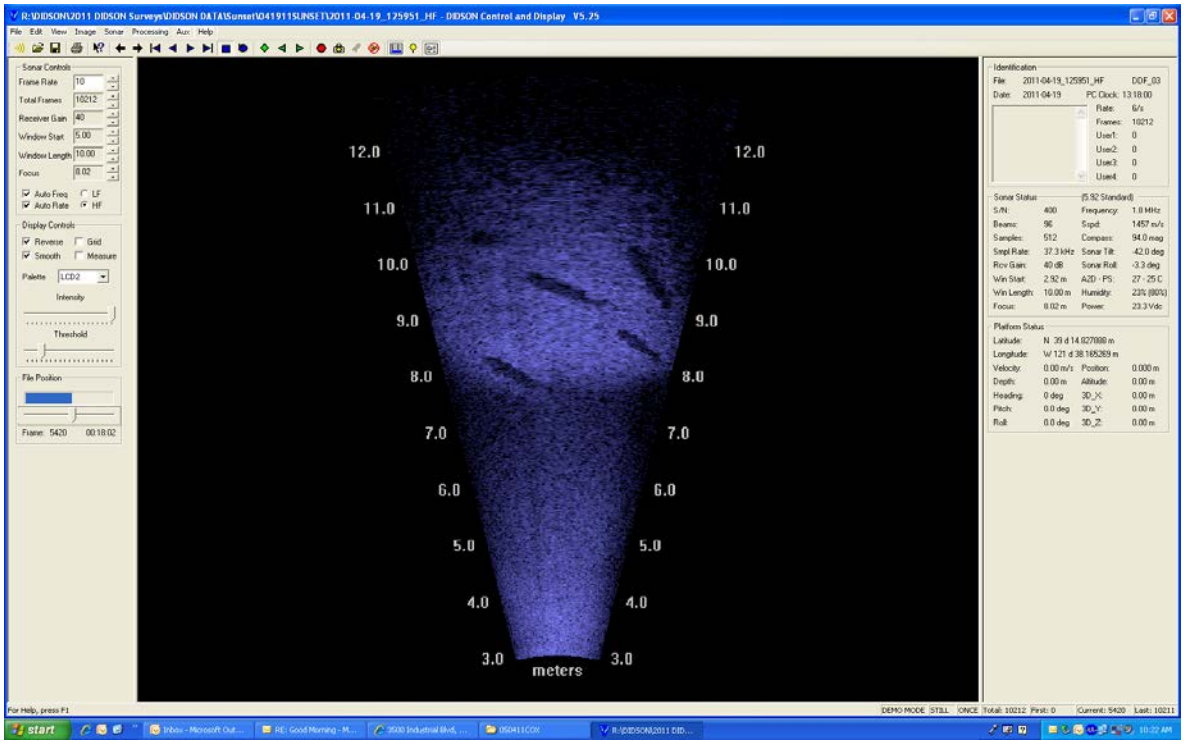



Figure 3. Sturgeon detected at downstream Sunset Pumps Pool on April 19, 2011.



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# ATTACHMENT B


# Big Sturgeon Hooked at Oroville

OROVILLE, Aug. 11.—A sturgeon weighing 120 pounds and measuring six feet in length was caught in the Feather river at Oroville this evening by Charles Matthews. The fish was landed after a struggle of three hours. An ordinary bass hook baited with minnow was used.

Later in the evening, Leonard York, a young lad, landed a 60 pound sturgeon.

Matthews and August Johnson hold the record for the largest sturgeon caught in the Feather river. It was captured last year and measured seven and a half feet in length and weighed 273 pounds.

# ATTACHMENT C

**Summary of Egg Verification by U.C. Davis Animal Sciences**
**Feather River Green Sturgeon Eggs Collected from Egg Mats during 2011**

From: Joel Van Eenenaam, Research Associate, U.C. Davis Animal Sciences

A total of 13 eggs were positively identified as green sturgeon, based on egg size, color and thickness of the egg chorion. The eggs collected are likely from 3 females, based on date/time of captures, water temperature, different stages of development and the assumption that it takes a female up to 20 hours to release all its eggs. The samples collected on 6/22 could have been from a female #4 but because it is not perfectly clear I would be conservative and say that these eggs came from at least 3 different females. There is a possibility that female #3 was large and spawned into 6/19 night time and that these eggs were moved around and stuck to the mat after being replaced on 6/20….

Since the rates of embryonic development and hatching time at temperature 15-16 °C are similar in green and white sturgeon (Deng et al., 2002) the rate of development established for white sturgeon (Wang et al., 1985; 1987) was used to make the estimates of day and time post-fertilization. Early development of white sturgeon follows the holoblastic style for all Acipenseriformes and the stages described in the spread sheet corresponds to the classification of Dettlaff et al. (1993).

In the laboratory, the egg diameter could be measured on 9 of the 13 eggs, and after fixation in alcohol some shrinkage is expected. The maximum length and width of the eggs collected were measure (± 0.001 mm) using a dissecting scope with camera lucida and a digital image-analyzing tablet (Nikon Microplan II). The mean maximum diameter (length) and width was 3.90 and 3.78, respectively.

For comparison, the average maximum length for green sturgeon eggs collected on mats in the Sacramento River during 2008-2010 (n=156) was 4.12 ± 0.20 mm (Poytress et al., 2009, 2010, 2011).

Eleven of the eggs were viable and two eggs were maybe fertilized and then died during embryogenesis. One was all marbled in color and was one covered in fungus.

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# ATTACHMENT E

## V. ENVIRONMENTAL BASELINE

7. North American Green Sturgeon

*a. Status in the Action Area*

**Adult green sturgeon currently occupy the lower Feather River downstream from Oroville Dam (RM 72) (Beamesderfer et al. 2004). Based on observations of adults, NMFS suspects that spawning may have occurred historically in the lower Feather River and a substantial amount of potential habitat in the Feather River was lost with the construction of Oroville Dam (Beamesderfer 2009). Significant habitat, while modified, remains accessible downstream from the Thermolito Afterbay Outlet (CDWR 2005a). USFWS (1995b) previously concluded that "evidence also suggests that sturgeon reproduction occurs in both the Feather and Bear rivers." The NMFS BRT (2005) assumed that a similar conclusion could be made for green sturgeon in the face of the paucity of data.**

Detailed information regarding historic and current abundance, distribution and seasonal occurrence of North American green sturgeon is limited due to limited monitoring efforts and fishery investigations. For example, unspecific historical reports of green sturgeon spawning in the Feather River (Wang 1986; USFWS 1995; CDFG 2002; CDWR 2007) have not been corroborated by observations of young fish or significant numbers of adults in focused sampling efforts (Schaffter and Kohlhorst 2002; Niggemyer and Duster 2003; Seesholtz 2003; Beamesderfer et al. 2004). Also, green sturgeon eggs, larvae, or juveniles have not been collected within these rivers (Beamesderfer 2009). **Although there is no evidence of spawning in the past or now, the continued persistence of adults in the system, and given the strong homing capabilities and high spawning site fidelity of sturgeon (Bemis and Kyndard 1997, Beamesderfer and Grey 2009), it is also reasonable to assume that green sturgeon are currently returning to the Feather River to spawn (David Woodbury, personal communications)**

There are numerous accounts of sturgeon being captured or observed by anglers and DWR fisheries scientists throughout the Lower Feather River, including the LFC and the HFC. The remainder of this section focuses on those accounts. The earliest account known to NMFS is a 1910 newspaper report of two sturgeon captured in the Feather River near Oroville in August of that year and one from the year prior but also in August. The sturgeon were 60, 120 and 273 pounds; and the report of the largest fish was accompanied by a photograph which clearly shows the fish to be a post-spawn green sturgeon (David Woodbury, NMFS, pers. com., 2011). In the mid-70s, green sturgeon were caught each year on the Feather River, with the majority of catches occurring from March to May and a few additional catches occurring in July and August (USFWS 1995). In 1993, seven adult green sturgeon were captured at the Thermalito Afterbay outlet, ranging in size from 60.9 to more than 73.2 inches (USFWS 1995). In a broad scale survey from 1999 to 2001, green sturgeon were infrequently observed within the action area downstream of the Thermalito Afterbay Outlet and none observed upstream (DWR 2003a). There are also unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (refer to Table 5-1; CDFG 2002). In 2006, four green sturgeons were positively identified by DWR biologists near the Thermalito Afterbay Outlet. Eight additional sturgeon

were also observed in the same area but could not be positively identified as green sturgeon (DWR 2007).

In recent years, as sturgeon monitoring has increased in the Central Valley, more information about sturgeon in the Feather River has become available (Seesholtz 2011). In 2008 and 2010, two green sturgeon tagged with VEMCO acoustic tags were detected in the river. The first was recorded at Beer Can Beach (River kilometer (Rkm) 14) from May 15-18, 2008. Discharge in this area was about 2100 cfs. The female left the system and was detected in the Sacramento River among the spawning grounds. On February 4, 2010, the second fish was detected at Star Bend (Rkm 29), stayed for several hours, and then it also migrated to the Sacramento River. Discharge in this area was about 2700 cfs. Previous studies suggested at least 5100 cfs was needed at Shanghai Bench in order for sturgeon passage (Seesholtz 2005). High flow events in early 2006 changed the bathymetry in this area that DWR now estimates it would require a discharge of about 5500 cfs to make Shanghai Bench passable for sturgeon upmigration.

While conducting DIDSON and underwater video surveys in the spring of 2011, DWR staff detected 30-40 sturgeon in the Feather River. All of these were identified by DWR staff as green sturgeon. One sturgeon was located with the DIDSON in the pool downstream of the Fish Barrier Dam (Rkm 108) in the LFC (Figure 5-1). Discharge in the LFC was as high as 12,000 cfs in March. It seems probable that other sturgeon also migrated this far upstream but headed back downstream as flows dropped to the base flow of 600 cfs. Approximately a dozen sturgeon were recorded around the Thermalito Afterbay Outlet Pool (Rkm 95). Another 20-25 sturgeon were located in the pool below Sunset Pumps (Rkm 61) which is downstream of the Oroville Facilities FERC Boundary about 25 river kilometers (Figure 5-2). Currently underwater video deployed in these areas to help determine species identification suggests the majority are green sturgeon; no whites have been identified with this method yet.

**Specific spawning locations for green sturgeon in the Feather River are unknown, but the most suitable habitat occurs in the area from Thermalito Afterbay outlet, downstream to near the Gridley Bridge (USFWS 1995b). Habitat investigations by DWR on the lower Feather River indicate that that there are up to 12 deep holes and over 13 miles of habitat from the Fish Barrier Dam at RM 67 to the downstream end of the Project Boundary at RM 54, with characteristics capable of attracting green sturgeon (Seescholtz 2003). Seven of these holes are greater than 5 meters deep, and 5 of the pools are between 3 and 5 meters (figure 5-3).**

**Table 5-1. Sturgeon sightings (confirmed and unconfirmed) from the Feather River since the 1990s.**

| Sturgeon Sightings | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | Location | Observation Type | Species | Size | Water Temperature* | | |
| | | | | | Avg | Max | Min |
| Late 1990's | Fish Barrier Dam Pool (LFC) | Biologist sighting | Sturgeon | NA | | | |
| Late 1990's | Table Mountain Bridge Pool (LFC) | Angler sighting | Sturgeon | ~ 6 feet | | | |
| May 11, 2000 | Afterbay Outlet (vicinity) | Biologist sighting | White sturgeon | ~3 feet | | | |
| May 18, 2000 | Afterbay Outlet (vicinity) | Biologist sighting | White sturgeon | ~3 feet | | | |
| Early 2000's | Matthews/Alec k Pool (LFC) | Angler sighting | Sturgeon | 5-6 feet | | | |
| March, 2002 | Shanghai Bend | Angler sighting | Sturgeon | NA | 62.0 | 69.3 | 56.4 |
| May 3, 2002 | Afterbay Outlet (vicinity) | Angler sighting | Green sturgeon | 5 feet | 59.4 | 63.9 | 54.6 |
| October, 2002 | Star Bend | Biologist sighting | Sturgeon | 4-5 feet | 62.0 | 62.9 | 56.1 |
| March, 2003 | Afterbay Outlet (vicinity) | Angler catch | Sturgeon | 7.875 feet (measur ed) | 54.1 | 59.5 | 49.2 |
| April, 2003 | Sunset Pumps | Angler sighting | Sturgeon | NA | 59.1 | 62.1 | 56.2 |
| July 3, 2003 | Afterbay Outlet (vicinity) | Angler catch | Green sturgeon | NA | 64.1 | 67.1 | 60.9 |
| April 8, 2004 | Afterbay Outlet (vicinity) | Angler catch | Green sturgeon | 65 pounds | 54.6 | 57.0 | 44.3 |
| April 8, 2004 | Afterbay Outlet (vicinity) | Angler catch | White sturgeon | 45 pounds | 54.6 | 57.0 | 44.3 |
| Early June, 2004 | Shanghai Bend | Biologist sighting | White sturgeon | NA | 69.9 | 73.6 | 64.8 |
| Early June, 2004 | Shanghai Bend | Biologist sighting | Green sturgeon | NA | 69.9 | 73.6 | 64.8 |
| December 22, 2004 | Gridley | Biologist sighting/angler catch | White sturgeon | 4 feet (measur ed) | 49.7 | 52.4 | 47.4 |
| March 24, 2005 | Shanghai Bend | Angler catch | Sturgeon | 5.8 feet, 80 pounds | 57.5 | 62.8 | 53.2 |
| June 23, 2005 | Afterbay Outlet (vicinity) | Biologist sighting/angler | Sturgeon | NA | 65.6 | 73.3 | 59.6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | catch | | | | | |
| Early April, 2006 | Gridley | Biologist sighting | Sturgeon | NA | 54.2 | 56.9 | 52.9 |
| Spring 2006 | Matthews/Alec k Pool (LFC) | Angler sighting | 2 Sturgeon | NA | | | |
| Spring 2006 | Matthews/Alec k Pool (LFC) | Angler catch | Green sturgeon | NA | | | |
| May 8, 2006 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | Green sturgeon | 6.5 feet (measur ed) | 59.1 | 62.2 | 56.0 |
| May 8, 2006 | Afterbay Outlet (vicinity) | Angler catch | 5 sturgeon | NA | 59.1 | 62.2 | 56.0 |
| May 12, 2006 | Afterbay Outlet (vicinity) | Angler catch | Sturgeon | NA | 59.1 | 62.2 | 56.0 |
| May 14, 2006 | Riverfront Park (near confluence of Yuba River) | Biologist sighting/angler catch | Sturgeon | < 3.8 feet | | | |
| May 27, 2006 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | Sturgeon | NA | | | |
| June 14, 2006 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | Green sturgeon | 5 feet | 62.9 | 67.3 | 57.3 |
| June 17, 2006 | Afterbay Outlet (vicinity) | Angler sighting | Sturgeon | NA | 62.9 | 67.3 | 57.3 |
| July 10, 2006 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | Green sturgeon | 6 feet | 64.7 | 69.2 | 57.3 |
| July 10, 2006 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | White sturgeon | 6 feet | 64.7 | 69.2 | 57.3 |
| July 17, 2006 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | Sturgeon | 7 feet | 64.7 | 69.2 | 57.3 |
| July 5-26, 2006 | Afterbay Outlet (vicinity) | Biologist sighting | Sturgeon | NA | 64.7 | 69.2 | 57.3 |
| March 15, 2008 | Afterbay Outlet (vicinity) | Biologist sighting/angler catch | White sturgeon | 4.95 feet | | | |
| May 15-18, 2008 | Star Bend | VEMCO detection | Green sturgeon | 4.85 feet when tagged in 2003 | | | |
| June 4, 2008 | Shanghai Bend | Biologist sighting | Green sturgeon | 6-6.5 feet | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| June 12, 2008 | Shanghai Bend | Biologist sighting | Green sturgeon | 6-6.5 feet | | | |

*Water temperatures represent daily average, maximum and minimum for approximate one month period surrounding the reported observation. Water are temperatures not available for all observations.

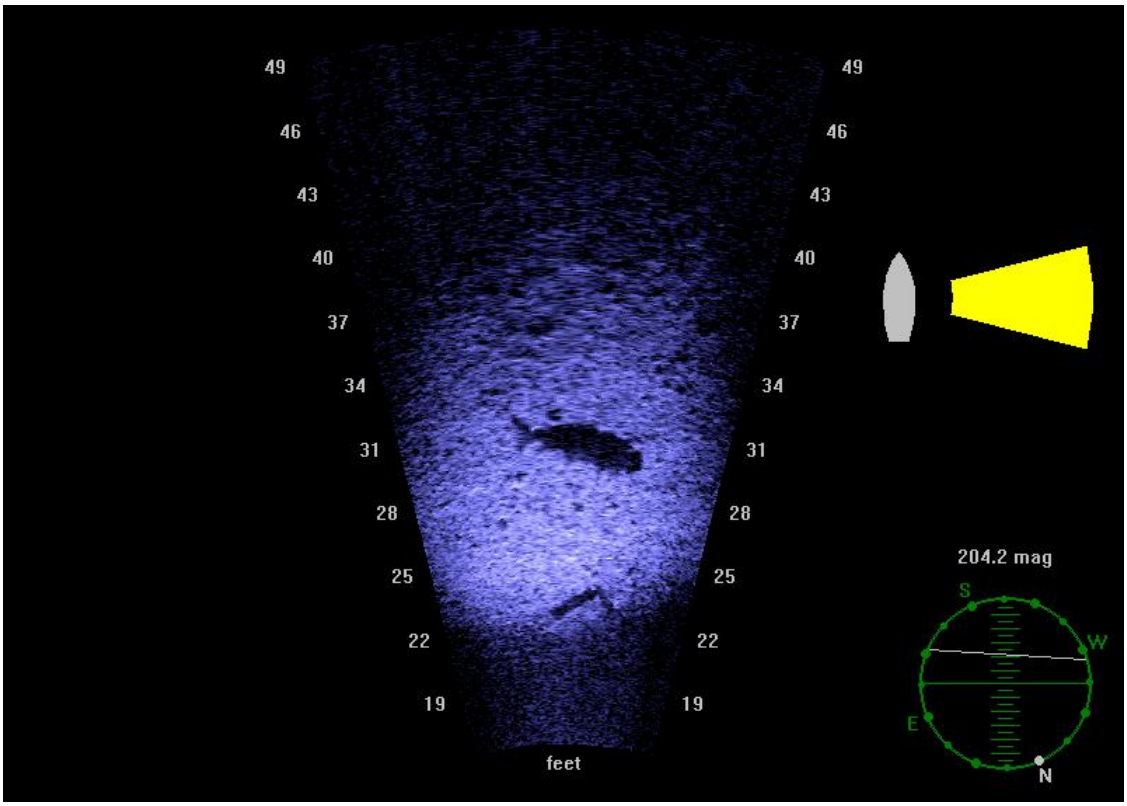


**Figure 5-1. Sturgeon detected at Fish Barrier Dam Pool on April 14, 2011.**

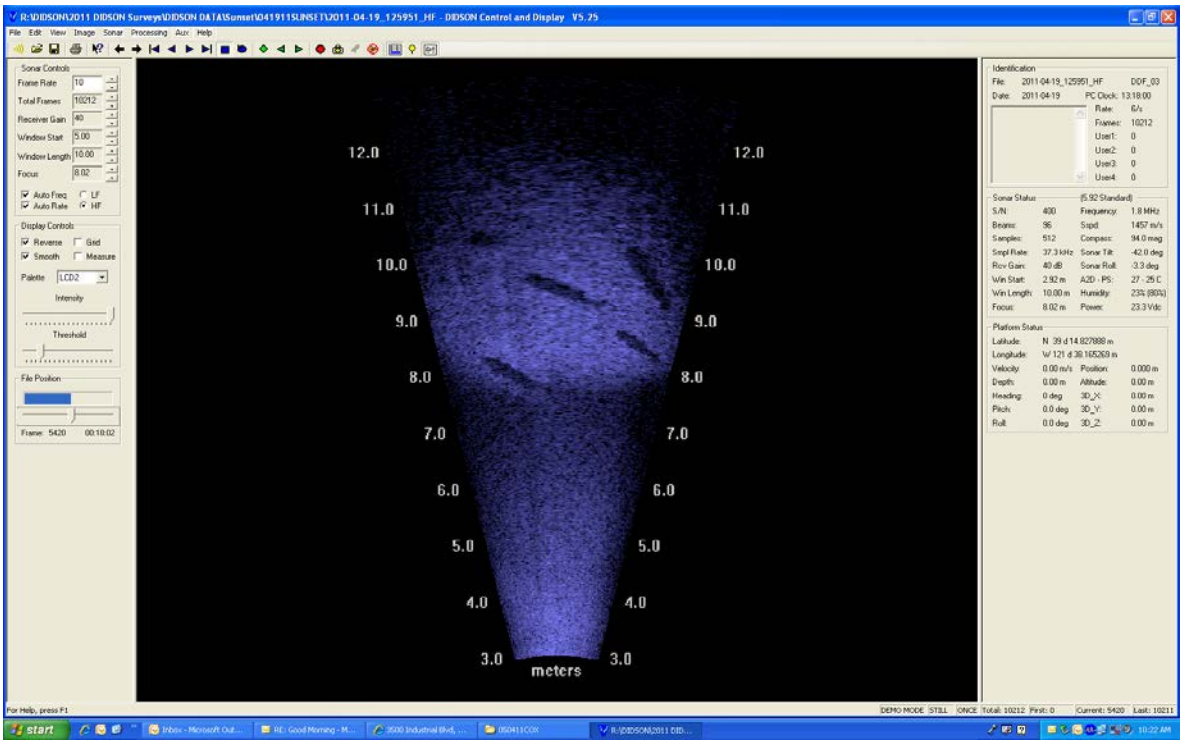


**Figure 5-2. Sturgeon detected at downstream Sunset Pumps Pool on April 19, 2011.**

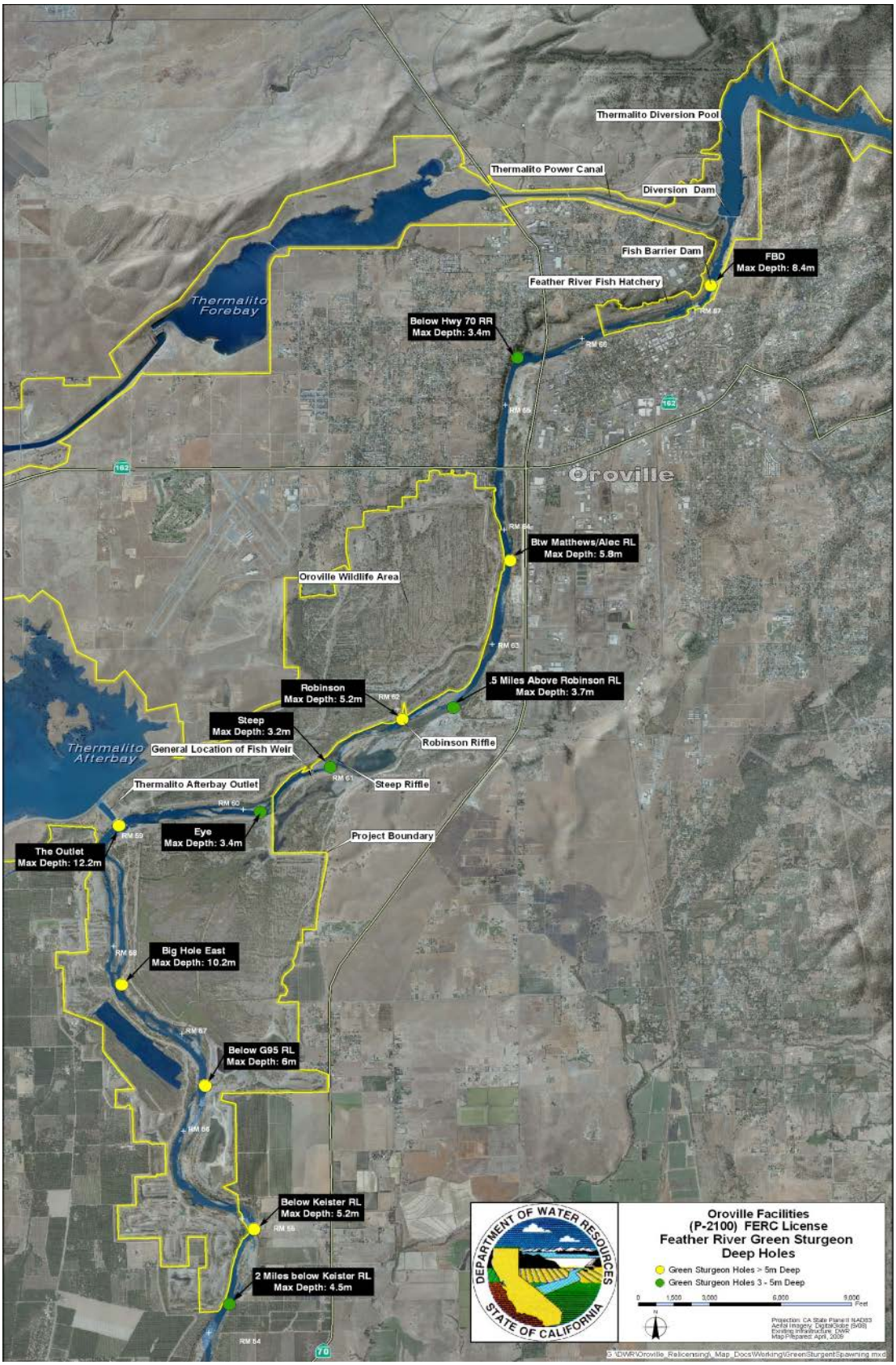


**Figure 5-3. Map of Deep Holes in the Feather River capable of supporting green sturgeon.**

*b. Factors Affecting the Status of North American Green Sturgeon in the Action Area*
The baseline stress regime in the action area is reflective of the history of water development and habitat modification that has been in place since 1968 with the completion of the Oroville Facilities. The facilities block fish passage, regulate flows and water temperatures, and alter the geomorphic processes of physical habitat development and change. Other stressors are related to introduced predatory fish species which are present throughout the Lower Feather River, but more predominant downstream from Gridley, near RM 50; and sportfishing, which also occurs throughout the river, but can be very high at the Thermalito Afterbay Outlet pool, where most green sturgeon are encountered on the Feather River.

**Fish Passage and Habitat Availability** - The construction of Oroville dam has blocked green sturgeon access to what were likely historic spawning grounds upstream (USFWS 1995a; NMFS 2004c) and has altered habitat conditions below the dam for adult migration, spawning, and juvenile rearing. Potential natural and man-made passage barriers in the lower Feather River may limit movement of sturgeon into the Feather River during low-flow years (Beamesderfer 2004). Potential barriers include Shanghai Bench (RM 24.5), a natural geologic feature; an artificial rock weir structure at Sunset Pumps (RM 38.5), and Steep Riffle (RM 61), a natural feature. At low flow conditions, Shanghai Bench and the Sunset Pumps are likely sturgeon passage barriers because of the height of their waterfalls, water velocities of the mid-channel chute, and/or lack of attraction flow within the potentially passable side channel. Although Shanghai Bench is likely passable for sturgeon during high-flow conditions, passage of the Sunset Pumps by sturgeon during the representative high-flow conditions is compromised. Steep Riffle represented the most reasonable passable potential barrier during representative low-flow and high-flow conditions. Passage determinations at each of the potential passage barriers in the lower Feather River would continue to be speculative without a greater understanding of sturgeon migration patterns and physiologic limitations (CDWR 2003), and changes in water elevations and bed load transport since dam construction (Beamesderfer 2009).

Impediments to migration may cause fish to stop their upstream migration or may delay access to spawning habitats (Moser and Ross, 1995). Natural (Shanghai Bench) and man-made (Sunset Pumps) impediments to upstream movements in the Feather River during low flow years might also limit significant spawning activities of green sturgeon above these obstacles to wet, high flow water years when they are more likely to be able to pass these obstacles (Beamesderfer *et al*. 2004, Beamesderfer 2009).

DWR has shown that while impoundments may prevent access to historical habitat, new habitat has also been created downstream of the dams, by the discharge of water that is colder than historical water temperatures, particularly during the summer months when early life stages would be present (DWR 2005b). The quantity and quality of this habitat is directly affected by river flows and water temperatures associated with the operation of the Oroville Facilities.

**Flows** - Low flow rates affect adult migration and may cause fish to stop their upstream migration or may delay access to spawning habitats. Flow rates can affect survival by affecting the dispersal of larvae to areas of greater food availability, the dispersal of larvae to all available habitats, the transportation of larvae downstream of water diversions in the Delta, or nutrient supply to the nursery areas (DFG 1992). Good recruitment of juvenile green sturgeon in the

Delta was observed during years where the mean monthly February through May flows ranged from 3,488 to 20,505 cfs at Gridley, and 7,028 to 35,234 cfs at Nicolaus (USFWS 1995b). These conditions correlate with wet and above average water year types; conditions that are known to be important to the production and abundance of green sturgeon.

**Water Temperatures** - Currently, water temperatures in the Lower Feather River are capable of supporting green sturgeon spawning during much of the spawning period, including what is considered the peak spawning period in April and May. From 1964 to 1994, water temperatures were within the optimal range for spawning 99 percent of the time from March through April from RM 67 downstream to RM 38.9 at the Sunset Pumps, a distance of approximately 28 river miles. During May, approximately 16 miles of habitat is within optimal ranges for 95 percent of days. Daily average water temperatures tend to be warmer in June, but are within optimal ranges for 88 percent of days at RM 54, and up to 82 percent of days at the Gridley Bridge (RM 51). During wet and above average, the conditions are much improved when optimal spawning temperatures in June are exceeded for only 11 to 15 percent of days downstream to RM 54 and 51, respectively (DWR 2009).

**Non-native Species** - Several non-native species that have been introduced into the system out-compete the native species, causing a replacement in the food sources available to green sturgeon. Green sturgeon juveniles and other juvenile fish may also experience predation by introduced species, including striped bass.

**Sportfishing** - Green sturgeon may be susceptible to sportfishing mortality. When harvest rates are high, population recovery is slow because of the green sturgeon's slow growth rate, long life span, and age at first spawn. Protective fishing regulations are now in place that prohibit green sturgeon harvest. In response to evidence of recent sturgeon declines, the California Fish and Game Commission approved CDFG proposed recreational fishing regulation changes for sturgeon on December 8, 2006. The regulations, effective March 1, 2007, prohibit retention of green sturgeon, alter the slot (size) limit and bag limit (3 individuals) for white sturgeon, and require implementation of a sturgeon report card system.

**Water Diversions and Exports** - The threat of screened and unscreened agricultural, and municipal and industrial (M&I) water diversions in the action area are largely unknown since juvenile sturgeon are often not identified, and current NMFS and DFG screen criteria have not been specifically formulated to protect sturgeon. Because of the temporal occurrence of juvenile green sturgeon and the high density of water diversion structures along rearing and migration routes, a potential threat exists to green sturgeon. NMFS (2005c) has recommended further studies to evaluate the significance of these threats.

**Climate Change –** The anticipated effects of climate change were previously described in the *Factors Affecting the Status of Central Valley Spring-run Chinook Salmon and Central Valley Steelhead in the Action Area* in this section of the biological opinion. The stressors are expected to affect green sturgeon in a similar manner by increasing water temperatures and decreasing the quantity and quality of cold water available to the species during critical life history periods such as spawning, larval development and early rearing.

*c. Likelihood of the Continued Existence of North American Green Sturgeon in the Action Area*

The best available information shows that green sturgeon habitat in the Feather River was lost with the construction of Oroville Dam (NMFS 2005), and green sturgeon have been displaced to downstream habitat, primarily below the Thermalito Afterbay Outlet (DWR 2007). There is uncertainty regarding the status of green sturgeon in the Feather River, but the limited available information shows that green sturgeon are present in the Feather River utilizing deep holes during the spawning period, and that this habitat contains pools of sufficient depth, velocity, and water temperature to support spawning, egg incubation and early juvenile rearing. This information shows that in spite of the habitat loss and exposure to a changed flow regime, suitable conditions exist in wet and above average water years, which are important water year types for green sturgeon reproduction and abundance, and that green sturgeon are likely to continue to exist in the Feather River.

*d. Importance of the Action Area to the Survival and Recovery of the Southern DPS of North American Green Sturgeon*

Much of the information that is available for the Southern DPS of North American green sturgeon indicates that the mainstem Sacramento River provides the most valuable spawning and rearing habitat for this species (NMFS 2005). There is uncertainty regarding the status of North American green sturgeon in the Feather River, however, the limited observations of green sturgeon within the action area, and the suitable habitat conditions during much of the spawning period shows that conditions are favorable enough that green sturgeon will continue to utilize the action area as a migratory corridor and for spawning and rearing.

The NMFS CHRT classified the lower Feather River as having a high conservation value to the DPS because it is consistently occupied by the species, it most likely contains spawning habitat and other PCEs that support several freshwater life history stages, the lower Feather River is a potential second spawning area in addition to the Sacramento River, and future habitat improvements are likely to have added value to the conservation of the species.

Although there is current uncertainty regarding the status of green sturgeon in the Feather River due, primarily due to a lack of monitoring and fishery investigations rather than an absence of fish, NMFS concludes that the value of the habitat is significant because it has the potential to provide a second distinct spawning area in the Sacramento River Basin, which would provide increased resiliency and reduce the risk of catastrophic effects to the DPS.

8. <u>North American Green Sturgeon Critical Habitat</u>

*a. Delineation of Critical Habitat for North American Green Sturgeon in the Action Area*

Critical habitat has recently been designated for the Southern DPS of North American green sturgeon and includes riverine habitat from the Feather River's confluence with the Sacramento River, upstream to the furthest accessible point below Oroville Dam. The riverine specific areas include areas that offer at least periodic passage of Southern DPS fish to upstream sites and include suitable habitat necessary for each riverine life stage (*e.g.*, spawning, egg incubation,

larval rearing, juvenile feeding, passage throughout the river, and/or passage into and out of estuarine or marine habitat).

*b. Status of Critical Habitat Primary Constituent Elements for North American Green Sturgeon in the Action Area*

**Food Resources** - The food resource needs for green sturgeon were described in detail in the *Status of the Species* section of this biological opinion. Strong hatches of mayflies, caddis flies, and chironomids occur in the upper Feather River, indicating that these groups of invertebrates are present in the river system. NMFS anticipates that the aquatic life stages of these insects (nymphs, larvae) would provide adequate nutritional resources for green sturgeon rearing in the river.

**Substrate Type or Size** - The substrate requirement for green sturgeon were described in detail in the *Status of the Species* section of this biological opinion. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Feather River downstream from Oroville Dam.

**Water Flow -** The flow requirements for green sturgeon were described in detail in the *Status of the Species* section of this biological opinion. The current suitability of these flow requirements in the Feather River is almost entirely dependent on releases from Oroville Dam and the Thermalito Afterbay. High spring flows associated with the natural hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that was seen in pre-dam conditions, but sufficient flow conditions exist to allow green sturgeon to migrate upstream even in dry water year types, as evidenced by the observation of adult green sturgeon in the upper river reaches below Oroville and the Fish Barrier Dams.

**Water Quality -** The water quality needs of green sturgeon were described in detail in the *Status of the Species* section of this biological opinion. Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages are required for the properly functioning of the freshwater habitat. Temperatures in the Lower Feather River are colder than they were historically, but are now influenced by the operation of Oroville Dam.

**Migratory Corridor -** The migration needs of green sturgeon were described in detail in the *Status of the Species* section of this biological opinion. Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g.*, an unobstructed river or dammed river that still allows for passage). Green sturgeon adults are blocked by Oroville dam, and may be impeded at other locations in the Lower Feather River during low flows (USFWS 1995b). However, sufficient flow conditions that allow green sturgeon to pass these areas occur during the migration period as evidenced by the observation of adult green sturgeon in the upper river reaches below Oroville and the Fish Barrier Dams in different water year types, including dry years.

**Depth** - The depth requirement of green sturgeon were described in detail in the *Status of the Species* section of this biological opinion. Pool depths of 3 m to greater than 5 m are critical for

adult green sturgeon spawning and for summer holding. Specific spawning locations for green sturgeon in the Feather River are unknown, but are probably limited to the area from Thermalito Afterbay outlet, downstream to near the Gridley Bridge (USFWS 1995b, Seescholtz 2003). More recent investigations of suitable deep pools indicate that there are up to 12 deep holes over 13 miles of habitat from the Fish Barrier Dam at RM 67 downstream to RM 54, with characteristics capable of attracting green sturgeon. Seven of these holes are greater than 5 meters deep, and 5 of the pools are between 3 and 5 meters. The total area of the pools is greater than 164,500 $m^2$.

*c. Summary of Critical Habitat for North American Green Sturgeon in the Action Area*

The migratory corridor, spawning habitat, food resource, temperature, flow, and other PCEs appear suitable to support several life history stages of green sturgeon including adult migration and spawning, and juvenile rearing and development. Although changed from historic conditions, the amount of habitat, the presence of conditions that support several life history stages, and the potential of the Feather River to represent a second area of spawning habitat for the DPS, make the Feather River an area of high conservation value.

## F. Importance of the Action Area to the Survival and Recovery of Listed Species

Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the southern DPS of North American green sturgeon are expected to continue to utilize the action area as a migratory corridor and for spawning and/or rearing. The value of the lower Feather River basin, within which the Oroville Facilities are located, as a migratory corridor, and its suitability as spawning and rearing habitat, make it an important node of habitat for the survival and recovery of local populations of these species. The continuity and connectivity of the Feather River to the rest of the action area is also important for the survival and recovery of these species.

Sacramento River winter-run Chinook salmon primarily utilize the mainstem of the Sacramento River, the Sacramento-San Joaquin Delta, and the Suisun Bay-San Pablo Bay-San Francisco bay complex and are not found extensively in the Feather River system. The population of Sacramento River winter-run Chinook salmon that now spawns below Keswick Dam is considered at moderate extinction risk according to Population Viability Analysis (PVA) (NMFS 2008). While Central Valley spring-run Chinook salmon populations in Butte, Deer and Mill Creeks are considered at low to moderate risk of extinction, the introgression of early returning Chinook salmon which persists within the FRFH and spawn in the Feather River below Oroville Dam, makes it difficult to assess the overall risk of extinction of the entire Central Valley spring-run Chinook salmon ESU. The current distribution of the last three independent populations makes the Central Valley spring-run Chinook salmon ESU vulnerable to catastrophic disturbance (*i.e.* drought, wildfires) (NMFS 2008).

Central Valley steelhead populations are currently classified as data deficient, meaning there is insufficient information to accurately determine their long-term viability, and, in all cases, hatchery-origin fish are likely to have adverse effects on the genetic composition of the natural

spawning population, placing the natural spawning population at high risk of extinction (NMFS 2008).

As with Sacramento River winter-run Chinook salmon, the information that is available for the Southern DPS of North American green sturgeon indicates that the mainstem Sacramento River may be the most valuable spawning and rearing habitat for this species (NMFS 2005). However, limited observations of green sturgeon within the action area indicate their dependence on Feather River habitat to some degree, particularly in above average and wet water years. Although limited, the value of the action area as migratory, spawning and rearing habitat may be significant. In addition, continuity and connectivity of the action area to other green sturgeon habitat makes it important for the survival and recovery of this DPS.

# ATTACHMENT F

# 10.0 REASONABLE AND PRUDENT ALTERNATIVE

NMFS has determined that the proposed action is likely to jeopardize the continued existence of the Federally threatened Southern DPS of North American green sturgeon and is likely to adversely modify the proposed critical habitat for the Federally threatenedSouthern DPS of North American green sturgeon. According to (50 CFR§402.14(h)(3)) NMFS is required to develop a reasonable and prudent measure to avoid jeopardy and/or adverse modification. Regulations (50 CFR §402.02) implementing section 7 of the ESA define reasonableand prudent alternatives as alternative actions, identified during formalconsultation, that: (1) can be implemented in a manner consistent with theintended purpose of the action; (2) can be implemented consistent with the scope ofthe action agency's legal authority and jurisdiction; (3) are economically andtechnologically feasible; and (4) would, NMFS believes, avoid the likelihood ofjeopardizing the continued existence of listed species or resulting in the destructionor adverse modification of critical habitat.Because this biological opinion has found that the proposed action is not likely to avoid jeopardy to the Southern DPS of North American green sturgeon or destruction or adversemodification of their proposed critical habitat, FERC is required to notify NMFS of itsfinal decision on the implementation of the reasonable and prudent alternatives.

The RPA must avoid jeopardy to listed species in the short term, as well as the long term. Essential short-term actions are presented for each division, and are summed for each species to ensure that the likelihood of survival is not appreciably reduced in the short-term (*i.e.*, 1 to 5 years). In addition, because the proposed action is long-term presence and operation of the Oroville Facilities, this consultation also includes long-term actions that are necessary to be identified, addressed, and implemented throughout the 50-year period of the license.

As an integral part of development of the RPA, NMFS considered economic and technological feasibility in several ways. The intent is to allow for tailored implementation of the RPA in consideration of these other factors, but do not compromise its effectiveness in avoiding jeopardy and adverse modification of proposed critical habitat. Examples include:

1. Including reasonable time to develop technologically feasible alternatives that are consistent with the Settlement Agreement.
2. Including a step-wise approach to long-term actions including feasibility studies and pilot phases, prior to a significant commitment of resources to construct projects or facility improvements.
3. Include reasonable and achievable interim estimates of habitat needs and water temperature requirements.
4. Including collection of monitoring data and research to inform implementation and effectiveness of actions.
5. Recognizes that green sturgeon are a long-lived species that are capable of spawning numerous times over the course of their existence, and while certain interim actions are necessary to prevent jeopardizing the species in the near term, other actions can be carried out over a longer period of time, and addressed as improved about the status and needs of the species develops.

Finally, the RPA allows for the development in the scientific understanding of the species and ecosystem to continue to evolve, and for the actions to adapt with the changing nature of science. This adaptive structure is important given the long-term nature of the consultation, and scientific uncertainty inherent in a highly variable system. Monitoring and adaptive management are both built into many of the implementation guidelines for the individual actions and are the subject of an annual program review. NMFS views both the CALFED Science Program, NMFS Southwest Fisheries Science Center, and other independent or academic green sturgeon experts as essential partners in ensuring that the best scientific experts are brought together to assess both the implementation and effectiveness of actions in this RPA.

## 10.1 Green Sturgeon Habitat Improvement Program

DWR shall develop and develop and implement a Green Sturgeon Habitat Improvement Program as part of the Lower Feather River Habitat Improvement Program to expand the range and temporal frequency of suitable spawning habitat necessary to improve the survival and production of green sturgeon and create conditions that will support a self sustaining viable population within the HFC of the Lower Feather River.

The program will focus on the two project related elements that the Biological Opinion found are significantly contributing to the poor viability of green sturgeon in the Feather River: water temperature, flow, and passage. The program shall include interim water temperature targets that shall be in place until a long-term program plan is developed and implemented. The program also will include research and monitoring, habitat evaluations, and the development of passage and spawning habitat improvement and water temperature criteria for the Lower Feather River.

### 10.1.1 Program Description

The Green Sturgeon Habitat Improvement Plan is designed to be consistent with the Settlement Agreement by building on the Water Temperature Improvement Plan (A108) to evaluate and implement facility modifications to extend cold water flows further downstream in the HFC. The goal of the program shall be to evaluate habitat conditions and population distribution of green sturgeon in the Lower Feather River and to create and implement habitat improvement actions, including, but not necessarily limited to water temperature improvements, that meet the life history processes and requirements of green sturgeon. We expect that given that very few details that are known about green sturgeon presence and habitat utilization in the Feather River, that the program will include habitat assessments and evaluations, monitoring, habitat suitability scenarios, habitat modeling, and water temperature improvements. To address these issues, the program will require the establishment of an expert panel of green sturgeon experts to serve as the steering committee for the program.

The Green Sturgeon Habitat Improvement Program includes several elements that are intended to be phased and implemented over time with the near-term goal of immediately improving water temperatures to stabilize conditions that support successful spawning, and longer term actions that will include, but should not be limited to passage at downstream impediments in the Feather River. Several actions are included in this program and are briefly described below in the Program Outline:

**Feather River Green Sturgeon Habitat Improvement Program**

I. Interim Measures
- Implementation of interim temperature target at Honcut Creek to increase the quantity and quality of green sturgeon spawning and early rearing habitat
- Implementation of fish passage flows during the adult upstream migration period

II. Green Sturgeon Habitat Improvement Steering Committee

III. Green Sturgeon Habitat Improvement Plan

A.Facility, Population and Habitat Evaluations
- Evaluating the Abundance and Distribution of Adult Green Sturgeon
- Characterization of Potential Green Sturgeon Spawning Grounds
- Feasibility Studies of Operational and Physical Facility Modifications for Water Temperature Improvement Actions
- Feasibility Studies of Operational and Physical Habitat Modifications for Fish Passage Improvement Actions

B.Criteria Development
- Establish Population Viability Goals, Objectives and Criteria
- Establish Habitat Improvement Goals, Objectives and Criteria
- Establish Water TemperatureGoals, Objectives and Criteria

C.Implementation
- Program Implementation
- Program Monitoring, Research, and Adaptive Management

D. Peer Review
- Independent peer reviews will be conducted to evaluate interim measures, and elements of the Green Sturgeon Habitat Improvement Plan as agreed upon by the steering committee and directed by the Ecological Committee.

## I. Interim Measures

DWR shall implement interim temperature targets at Honcut Creek to increase the quantity and quality of green sturgeon spawning habitat, and improve conditions for egg incubation, larval development, and early rearing. With the exception of Conference Years, the average daily water temperature at Honcut Creek shall not exceed $64^{o}$ F from April 1 through July 1. These targets would become criteria after DWR evaluates and implements any facility modifications pursuant to the tasks and schedule described in Article 108 of the Settlement Agreement for the Lower Feather River Habitat Improvement Plan.During Conference Years, DWR shall implement Conference Actions as described in the *Project Description* section of this Biological Opinion, except that the strategic plan shall include actions necessary to meet the temperature requirement at Honcut Creek.

DWR shall implement interim pulse flows to facilitate adult sturgeon passage at Shanghai Bench and Sunset Pumps during the months of April and May. Given the current uncertainty regarding the magnitude and duration of flow that would be required to accomplish upstream passage, DWR shall consult with an independent expert green sturgeon panel to develop interim green sturgeon pulse flow criteria for dry, average, and wet water year types. These criteria shall be adopted by DWR and implemented beginning in the first year of the new license and until such time that long-term physical or operational passage measaures are in place.

### II. Steering Committee

Within six months of the issuance of the new license, the Ecological Committee will assemble and charter a Green Sturgeon Habitat Improvement Program Steering Committee to develop a Green Sturgeon Habitat Improvement Plan. The committee shall be chaired by DWR and comprised of biologists from DWR, NMFS, and DFG, and at least one local, academic green sturgeon expert. Agency science programs and science centers shall be used as resources to the steering committee.

The Steering Committee has responsibility to gather and analyze information, and make recommendations, regarding adjustments to water operations, passage evaluations and actions, and other adaptive management actions necessary to improve conditions or reduce adverse impacts to green sturgeon in the action area. DWR shall send to NMFS a list of the members and a draft copy of the Committee's Charter. NMFS shall review the membership Charter and make recommendations for change as necessary.

## III.Green Sturgeon Habitat Improvement Plan

Within two years of the license, the Green Sturgeon Habitat Improvement Program Steering Committee shall produce a Green Sturgeon Habitat Improvement Plan. The plan will include a schedule, strategy, and approach for conducting facility and population evaluations, characterization of habitats, and feasibility studies for actions necessary to improve passage conditions and spawning habitat in the Lower Feather River. The plan also will develop a schedule, strategy and approach for developing population viability criteria, and long term habitat actions, facility improvements, and monitoring necessary to measure the effectiveness of actions and progress toward achieving population viability.

### A. Facility, Population and Habitat Evaluations

**Evaluating the Abundance and Distribution of Green Sturgeon** - The lack of information describing the number of annual spawning adults, as well as the total population size of the Southern DPS of green sturgeon, was acknowledged as a source of uncertainty in making status evaluations for ESA recommendations (BRT 2005). Effective conservation of green sturgeon will require better information on their patterns of habitat use in time and space.

DWR shall, under the purview of the Steering Committee, develop and implementa monitoring and evaluation study that will estimate the abundance of adult green sturgeon in the Lower

Feather River, describe their distribution in time and space; and investigate the effect of Oroville operations on their passage success and distribution. NMFS recommends an approach that applies Dual Frequency Identification Sonar (DISON) surveys and passive hydroacoustics. Surveys on the Rogue and Sacramento River have shown that the DIDSON can be used to count green sturgeon in potentially turbid river channels. Another estimate of the abundance of green sturgeon can be obtained by combining the estimates for each sampled reach with passive acoustic data. There are potentially many green sturgeon carrying acoustic transmitters from tagging studies that have already been initiated. Tagged sturgeon can be tracked using a mobile hydrophone and adult estimates can be used from hydrophone detections.

**Characterization of Potential Green Sturgeon Spawning Habitats** - The habitat requirements for green sturgeon are poorly known; however there are indications that cold, clean water is required for spawning. Spawning aggregations of green sturgeon have been identified at certain stretches along the upper Sacramento River during tracking and telemetry studies carried out by researchers at UC Davis. However, little is known about the micro-habitat conditions which determine whether a particular site is a good spawning area or not, other than depth (areas of approximately homogenous 5 m depth appear to be preferred) and possible current complexity.

Acoustic Doppler Current Profiler (ADCP) can be used to create a cross channel vertical profile of current and temperature in potential spawning areas. Analysis of the data can be used to characterize pools and provide insight into existing habitat variables and used to determine whether or not a site is appropriate for spawning.

**Feasibility Studies of Operational and Physical Facility Modifications for Water Temperature Improvement Actions** – As described in A108 of the Settlement Agreement,DWR would develop and, on approval by FERC, implement one or more Project Facilities Modifications for the benefit of anadromous fish holding, spawning, egg incubation, and rearing habitat in the LFC and HFC in the least costly manner. DWR shall expand the studies to consider the benefits to green sturgeon downstream from the project boundary. The study would clearly identify potential operational and facility modifications necessary to meet the interim water temperature targets at Honcut Creek, temperature criteria, except in conference years. When complete, the study would recommend a specific alternative for implementation. After the testing period, the ability of the project to meet temperatures would be reviewed, and permanent temperature requirements for the HFC would be developed.

**Feasibility Studies of Operational and Physical Habitat Modifications for Fish Passage Improvement Actions** – DWR will conduct feasibility studies of operational and physical habitat modifications necessary to achieve unobstructed passage conditions throughout the Feather River, including, but not limited to, Shanghai Bench and the Sunset Pumps. Passage criteria shall be developed using the best available scientific or commercial information, much of which is currently being developed at the University of California at Davis, with funding support from DWR. The feasibility report shall be completed within three years, and passage projects shall be initiated within five years.

**B. Criteria Development**

**Establish Population Viability Criteria** – The Steering Committee shall develop green sturgeon population viability criteria for the Feather River. The criteria shall address abundance, production, diversity, and spatial structure of spawning adults. Due to the uncertainties regarding green sturgeon distribution, abundance, and habitat use, development of these criteria is not immediately possible. DWR shall develop these criteria concurrent with the development of viability criteria for the full DPS by the green sturgeon technical recovery team. Once the criteria are developed, they shall be recommended to the Ecological Committee as viability targets, and DWR shall use all of their programs and authorities to achieve these targets over the period of the license.

**Establish Habitat Improvement Goals, Objectives, and Criteria** – DWR shall develop habitat improvement goals, objectives, and effectiveness criteria that address achieving green sturgeon population viability in the Lower Feather River.

**Establish Water Temperature Goals, Objectives, and Criteria** - DWR shall develop long term water temperature improvement goals, objectives, and effectiveness criteria that address achieving green sturgeon population viability in the Lower Feather River. These also should address and develop an action plan for managing water temperatures under the predicted climate change scenarios to minimize long-term risk to green sturgeon.

**C. Implementation**

**Program Implementation** – The Green Sturgeon Habitat Improvement Plan shall develop an implementation plan and schedule. The plan shall include a list of actions and dates for completing habitat improvement actions.

**Program Monitoringand Research** - The Green Sturgeon Habitat Improvement Plan shall develop a green sturgeon monitoring and research plan that shall include developing long-term adult population estimates, and collecting information on green sturgeon passage, spawning, rearing, and growth, and related habitat utilization in the Feather River.

**Adaptive Management** – The Green Sturgeon Habitat Improvement Plan shall include an adaptive management strategy that allows for developments in the scientific understanding of the species and ecosystem to continue to evolve, and for the actions to adapt with the changing nature of the best available science.

**D. Peer Review**

NMFS views the CALFED Science Program, NMFS Southwest Fisheries Science Center, and other independent or academic green sturgeon experts as essential partners in ensuring that the best scientific experts are brought together to assess both the implementation and effectiveness of actions in this RPA. The Green Sturgeon Habitat Improvement Plan shall include a strategy for seeking peer review of the plan and its various components, but also to review and provide feedback on the long term implementation, monitoring, and research associated with implementation and adaptive management of the 50 year period of the license.

### 10.1.2 Description of How the Measure Avoids Jeopardy and Adverse Modification

The measure is expected in avoid jeopardy through a combination of short-term actions that will increase the spatial availability of spawning habitat, and by creating water temperatures that are more consistently within the thermal optima for green sturgeon throughout the spawning, egg incubation, and early larval rearing period. The interim water temperature measure will increase the amount of suitable spawning habitat from RM 54 downstream to RM 44, an increase of 10 miles, thus significantly addressing a limiting factor for green sturgeon production and viability, and increasing juvenile population abundance, and spatial distribution in the Feather River. Over the longer term, the monitoring, research, and habitat evaluations will lead to the development of water temperature recommendations and criteria that are more rigorous and suitable for improving the population's long-term viability.

The interim fish passage improvement measures will provide seasonal pulse flows that correspond with the adult migration period and will provide periodic windows of opportunity for upstream migration to spawning habitat. This is expected to increase the number of individuals that are able to access improved spawning conditions, and therefore is expected to have a positive effect on population abundance and life history diversity. Over the longer term, the monitoring, research, and habitat evaluations will lead to the implementation of fish passage improvement projects that will further increase the passage success of adults by improving passage conditions to a broader range of project flows. These long-term improvements will more consistent upstream migration conditions and are expected to have a positive effect on population abundance and life history diversity.

The monitoring, research, and adaptive management components of the Green Sturgeon Habitat Improvement Program will evaluate the effectiveness of the program, and make adjustments as necessary to increase production of green sturgeon in the Lower Feather River. Ultimately, the Green Sturgeon Habitat Improvement is expected to result in the establishment of a second population of green sturgeon in the DPS, which will increase the viability of the DPS by result in an increase in the overall production and abundance, an increase in life history diversity, and an increase in spatial distribution throughout the DPS' range. These improvements are expected to reduce the risk factors that currently are faced by the single known spawning population in the Sacramento River.