

habits of green sturgeon are presented below.

Distribution. San Francisco Bay and its associated river systems contain the southern-most spawning population of green sturgeon. White sturgeon supports a large fishery in this area, particularly in San Pablo Bay, which has been extensively studied by California Department of Fish and Game (CDFG) since the 1940's. While green sturgeon are not common, they are collected incidentally in a white sturgeon trammel net monitoring program during most years in numbers ranging from 5 to 110 fish. Green sturgeon juveniles are found throughout the Delta and San Francisco Bay.

Green sturgeon adults and juveniles occur throughout the upper Sacramento River. Green sturgeon are reported to spawn in the Feather River, but this has not been substantiated. Green sturgeon spawning occurs predominately in the upper Sacramento River. Juvenile sturgeon have been taken annually in trapping operations at the RBDD (1995–2001) and at the Glenn-Colusa Irrigation District pumping facility as part of a monitoring program (1986–2001). All larval and juvenile sturgeon caught at these locations are assumed to be green sturgeon because juveniles collected at these sites and grown to identifiable size were green sturgeon. There is no documentation of green sturgeon spawning in the San Joaquin River at present, but there may have been spawning there before construction of large-scale hydropower and irrigation development. Young green sturgeon have been taken occasionally in the Santa Clara Shoal area in the San Joaquin delta but these fish likely originated from elsewhere, most likely the Sacramento River (CDFG 2002).

Green sturgeon also occur in the coastal waters of the Pacific Ocean off California and in coastal rivers. Small numbers have been taken in both Tomales Bay and Bodega Bay and a single fish has been taken from the Noyo River. They are regularly taken in small numbers in Humboldt Bay, and have been caught in coastal waters and in estuaries from Arcata Bay to the Oregon border. Small numbers of both adult and juvenile green sturgeon have been observed in the Eel River.

The largest spawning population of green sturgeon is thought to occur in the Klamath River on the north coast of California, but there are no direct estimates of green sturgeon abundance. Adults are captured in the salmon gill net fisheries conducted by the Yurok and Hoopa Indian tribes and adults occur upstream in the Klamath to a natural migration barrier at Ishi Pishi

Falls (rkm 107). Juvenile green sturgeon are captured each year on the Klamath River and have also been found in the lower portion of the Salmon River which is a tributary to the Klamath River. Adults occur in the Trinity River, a major tributary to the Klamath River, to Gray's Falls (rkm 69), but spawning can only be confirmed up to the Willow Creek trap (rkm 40). Moyle *et al.* (1992) reported no evidence of spawning in the South Fork of the Trinity River.

The Rogue River in Oregon was recently confirmed as a third spawning area for green sturgeon (Erickson *et al.*, 2001, Rien *et al.*, 2001). Based on tracking of radio-tagged adults captured in the estuary, extended holding sites were identified that have been associated with spawning in other species of sturgeon. Juvenile fish are taken in beach seining efforts in the estuary (Rien *et al.*, 2001). Green sturgeon adults are taken in almost all of the Oregon coastal estuaries from the Chetco River to Nehalem Bay (EPIC *et al.*, 2001). During white sturgeon tagging projects in Coos Bay (Coos River), Winchester Bay (Umpqua River), Yaquina Bay (Yaquina River), and Tillamook Bay (Tillamook River) green sturgeon have been captured and tagged; however, no recoveries have been reported (ODFW 2002).

The Columbia River has supported a large white sturgeon fishery for many years in which green sturgeon are taken as bycatch. In the mid 1930's before Bonneville dam, green sturgeon were found up to the Cascade Rapids. Green sturgeon are presently found up river to the Bonneville Dam (rkm 235), but are predominately found in the lower 60 rkm. Tagging studies indicate a substantial exchange of fish between the Columbia River and Willapa Bay (WDFW 2002a). Willapa Bay, along with the Columbia River and Grays Harbor, is one of the estuaries where green sturgeon concentrate in summer. Generally, green sturgeon are more abundant than white sturgeon in Willapa Bay (Emmett *et al.*, 1991).

Grays Harbor in Washington is the northernmost estuary with green sturgeon summer concentrations and there are both tribal and commercial fisheries that take green sturgeon. There are no records of juveniles from Grays Harbor. Green sturgeon occur sporadically in small numbers throughout coastal Washington (WDFW 2002a) and are routinely encountered in the coastal Washington trawl fishery as minor incidental catch (WDFW 2002b). Occasionally, green sturgeon are caught in small coastal bays and estuaries during tribal salmon fisheries. A few green sturgeon are recovered in Puget

Sound as incidental harvest (mostly trawl fisheries).

Green sturgeon occur in small numbers along the western coast of Vancouver Island (Houston 1988) and the Skeena River. Historically, green sturgeon were not uncommon in the Fraser River (EPIC *et al.*, 2001). Since the collapse of the Fraser River white sturgeon fishery, however, green sturgeon are only taken there occasionally.

Spawning. Green sturgeon are thought to spawn every 3 to 5 years (Tracy 1990). Their spawning period is March to July, with a peak in mid-April to mid-June (Moyle *et al.*, 1992). Mature males range from 139–199 cm in fork length (FL) and 15 to 30 years of age (VanEennaam 2002). Mature females range from 157–223 cm FL and 17 to 40 years of age. Most of the spawning males are 160–170 cm FL and 17–18 years old, while most of the spawning females are 182–192 cm FL and 27–28 years old.

Green sturgeon spawning occurs in deep pools or "holes" in large, turbulent river mainstems (Moyle *et al.*, 1992). Specific spawning habitat preferences are likely large cobble substrates, but may range from clean sand to bedrock substrates as well. Eggs are likely broadcast over the large cobble substrates where they settle into the space between the cobble. Green sturgeon females produce 60,000–140,000 eggs (Moyle *et al.*, 1992) and they are the largest eggs (diameter 4.34 mm) of any sturgeon species (Cech *et al.*, 2000). Temperatures above 20 C are lethal to green sturgeon embryos (Cech *et al.*, 2000).

Green sturgeon spawning has only been documented in the Klamath, Sacramento (Moyle *et al.*, 1992, CDFG 2002) and Rogue (Erickson *et al.*, 2001, Rien *et al.*, 2001) rivers in recent times. The Klamath Basin is thought to support the largest green sturgeon spawning population (Moyle *et al.*, 1992). In the Klamath River, breaching and other suspected sturgeon courtship behaviors have been observed in "The Sturgeon Hole" upstream of Orleans (rkm 96). Larvae and juveniles are caught in the Big Bar trap (rkm 80) on the Klamath and in the Willow Creek trap (rkm 40) on the Trinity. Numbers at both traps have a peak in July (Healey 1973).

In the Sacramento River, green sturgeon spawn in late spring and early summer above Hamilton City and perhaps as far upstream as Keswick Dam (CDFG 2002). The opening of the Red Bluff Diversion Dam (RBDD) gates to improve winter-run chinook upstream and downstream passage is believed to have provided a substantial