

increase in spawning habitat for green sturgeon in the upper Sacramento River. The gates were first opened in 1986 and the current pattern of operation began in 1992–93. Juvenile green sturgeon are taken in traps at the RBDD and the Glenn Colusa Irrigation District's (GCID) facility in Hamilton City, primarily in the months of May through August. Peak counts occur in the months of June and July.

Green sturgeon spawning has been recently documented in the Rogue River (Erickson *et al.*, 2001, Rien *et al.*, 2001). Adult fish were radio-tagged in the estuary during May–June 2000. After release, tagged ripe fish moved up the Rogue River to spawn, while non-reproductive fish remained close to the tagging site. Spawning fish spent more than 6 months in freshwater and traveled as far as rkm 39. All tagged individuals emigrated from freshwater during fall and winter when water temperatures fell below 10 C. Juvenile green sturgeon have been taken in beach seines in the Rogue River estuary from April until the end of November (Rien *et al.*, 2001).

Apparently, green sturgeon no longer spawn in some river systems where they once did (CDFG 2002). Juvenile green sturgeon were captured in the Eel River in traps at Rio Dell (rkm 20) and Dos Rios (rkm 191) during the period from 1967 to 1970 (Puckett 1976). Single or small numbers of adult green sturgeon are also observed periodically in the Eel River. Similarly, green sturgeon are reported to have spawned in the South Fork Trinity River, but apparently no longer do so due to extensive sedimentation from the 1964 flood (Moyle *et al.*, 1992). The validity of reports of green sturgeon spawning in the Umpqua River is unclear (Lauman *et al.*, 1972) and the possibility of current spawning activity is being investigated (ODFW 2002).

**Early Life History.** Green sturgeon larvae first feed at 10 days post hatch, and metamorphosis to the juvenile stage is complete at 45 days. Larvae grow fast, reaching a length of 66 mm and a weight of 1.8 g in 3 weeks of exogenous feeding. Juveniles averaged 29 mm at the peak of occurrence in June–July at the RBDD fish trap and 36 mm at their peak abundance in July at the GCID trap. These growth rates are consistent with rapid juvenile growth to 300 mm in 1 year and to over 600 mm within 2–3 years for the Klamath River (Nakamoto *et al.*, 1995). Juveniles appear to spend 1 to 3 years in freshwater before they enter the ocean (Nakamoto *et al.*, 1995).

**Ocean Residence.** Green sturgeon disperse widely in the ocean after their out-migration from freshwater (Moyle *et*

*al.*, 1992). Tagged green sturgeon from the Sacramento and Columbia Rivers are primarily captured to the north in coastal and estuarine waters, with some fish tagged in the Columbia being recaptured as far north as British Columbia (WDFW 2002a). While there is some bias associated with recovery of tagged fish through commercial fishing, the pattern of a northern migration is supported by the large concentration of green sturgeon in the Columbia River estuary, Willapa Bay, and Grays Harbor which peaks in August. These fish tend to be immature; however, mature fish and at least one ripe fish have been found in the lower Columbia River (WDFW 2002a). Genetic evidence suggests that Columbia River green sturgeon are a mixture of fish from at least the Sacramento, Klamath, and Rogue Rivers (Israel *et al.*, 2002). The reasons for the concentration of green sturgeon in Oregon and Washington estuaries during the summer are unknown as there is no known spawning in these rivers and all stomachs examined to date have been empty (Beamesderfer 2000).

**Age and Growth.** Green sturgeon is a long-lived, slow-growing species as are all sturgeon species (Nakamoto *et al.*, 1995, Farr *et al.*, 2002). Size-at-age is consistently smaller for fish from the Klamath River (Nakamoto *et al.*, 1995) in comparison to fish from Oregon until around age 25, but thereafter the pattern is reversed. This could be the result of actual differences in growth or in ageing techniques. The asymptotic length for Klamath fish of 218 cm is close to the maximum observed size of 230 cm reported by Moyle *et al.* (1992), but substantially larger than for fish in Oregon (females 182 cm, males 168 cm).

**Feeding.** Little is known about green sturgeon feeding. Adults in the Sacramento-San Joaquin delta feed on benthic invertebrates including shrimp, mollusks, amphipods, and even small fish (Moyle *et al.*, 1992). Juveniles in the Sacramento-San Joaquin Delta feed on opossum shrimp and amphipods (Radtko 1966). One hundred and twenty-one green sturgeon stomach samples from the Columbia River gill-net fishery were empty with the exception of one fish, while all white sturgeon stomachs contained digested material (ODFW 2002).

#### Consideration as a "Species" Under the ESA

To qualify for listing as a threatened or endangered species the petitioned North American green sturgeon must be considered a species under the ESA. Section 3(16) of the ESA (16 U.S.C. 1532(16)) expands the definition of a

"species" under the ESA to include any subspecies or any "distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature." On February 7, 1996, the U.S. Fish and Wildlife Service and NMFS adopted a policy to clarify their interpretation of the phrase "distinct population segment of any species of vertebrate fish or wildlife" for purposes of listing, delisting, and reclassifying species under the ESA (61 FR 4722). This joint policy identifies two elements that must be considered when making DPS determinations: (1) The discreteness of the population segment in relation to the remainder of the species (or subspecies) to which it belongs; and (2) the significance of the population segment to the species or subspecies to which it belongs.

According to the joint policy, a population segment may be considered discrete if it satisfies either one of the following conditions: (1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors; or (2) it is delimited by international governmental boundaries across which there is a significant difference in exploitation control, habitat management, or conservation status. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.

The joint policy states that the following are some of the considerations that may be used when determining the significance of a population segment to the taxon to which it belongs: (1) persistence of the discrete population in an unusual or unique ecological setting for the taxon; (2) evidence that the loss of the discrete population segment would cause a significant gap in the taxon's range; (3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere; or (4) evidence that the discrete population segment has marked genetic differences from other populations of the species.

#### Species Status and DPS Structure

**Species Status.** Green sturgeon that occur within U.S. and Canadian waters are a geographically isolated and genetically distinct species. The North American form was initially considered conspecific with the previously described Asian species, Sakhalin sturgeon (*A. mikadoi*), and the two forms were synonymized (Berg, 1948). More recent molecular data on three mitochondrial genes, however, show great differences between the North