

based on geography, degree of connectedness, and genetic interchange (Lande and Barrowclough, 1987; and King *et al.*, 2001). Seven subpopulations are described in the "Critical Habitat Unit Descriptions" section of this rule.

Feeding Habits

Gulf sturgeon feeding habits in freshwater vary depending on the fish's life history stage (*i.e.*, young-of-the-year, juvenile, subadult, adult). Young-of-the-year Gulf sturgeon remain in freshwater feeding on aquatic invertebrates and detritus approximately 10 to 12 months after spawning occurs (Mason and Clugston, 1993; and Sulak and Clugston, 1999). Juveniles (less than 5 kg (11 lbs) are believed to forage extensively and exploit scarce food resources throughout the river, including aquatic insects (*e.g.*, mayflies and caddisflies), worms (oligochaetes), and bivalve molluscs (Huff, 1975; and Mason and Clugston, 1993). Juvenile (ages 1 to 6) Gulf sturgeon collected in the Suwannee River are trophically active (foraging) near the river mouth at the estuary, but trophically dormant (not foraging) in summer holding areas upriver—a portion of the juvenile population reside and feed year round near the river mouth at the estuary, not just in winter (K. Sulak, U.S. Geological Survey (USGS), pers. comm. 2002). In the Choctawhatchee River, juvenile (ages 1 to 6) Gulf sturgeon did not remain near the estuary at the river mouth for the entire year, instead, they were located during winter months in Choctawhatchee Bay and returned upriver to resting areas in the spring (F. Parauka, FWS, pers. comm. 2002). Subadult (age 6 to sexual maturity) and adult (sexually mature) Gulf sturgeon do not feed in freshwater (Wooley and Crateau, 1985; and Mason and Clugston, 1993).

Many reports indicate that adult and subadult Gulf sturgeon lose a substantial percentage of their body weight while in freshwater (Wooley and Crateau, 1985; Mason and Clugston, 1993; and Clugston *et al.*, 1995) and then compensate the loss during winter feeding in the estuarine and marine environments (Wooley and Crateau, 1985; and Clugston *et al.*, 1995). Gu *et al.* (2001) tested the hypothesis that subadult and adult Gulf sturgeon do not feed significantly during their annual residence in freshwater by comparing stable carbon isotope ratios of tissue samples from subadult and adult Suwannee River Gulf sturgeon and their potential freshwater and marine food sources. A large difference in isotope ratios between freshwater food sources and fish muscle tissue suggests that

subadult and adult Gulf sturgeon do not feed significantly in freshwater. The isotope similarity between Gulf sturgeon and marine food resources strongly indicates that this species relies almost entirely on the marine food web for its growth (Gu *et al.*, 2001).

Once subadult and adult Gulf sturgeon leave the river, having spent at least 6 months in the river fasting, we presume that they immediately begin feeding. Upon exiting the rivers, Gulf sturgeon are found in high concentrations near their natal river mouths. Lakes and bays at the mouths of the river systems where Gulf sturgeon occur are important because they offer the first opportunity for Gulf sturgeon exiting their natal rivers to forage. Gulf sturgeon must be able to consume sufficient quantities of prey while in estuarine and marine waters to regain the weight they lose while in the river system and to maintain positive growth on a yearly basis. In addition, reproductively active Gulf sturgeon require additional food resources to obtain sufficient energy necessary for reproduction (Fox *et al.*, 2002; and D. Murie and D. Parkyn, University of Florida (UF), pers. comm. 2002).

Adult and subadult Gulf sturgeon, while in marine and estuarine habitat, are thought to forage opportunistically (Huff, 1975), primarily on benthic (bottom dwelling) invertebrates. Gut content analyses have indicated that the Gulf sturgeon's diet is predominantly amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, molluscs, and crustaceans (Huff, 1975; Mason and Clugston, 1993; Carr *et al.*, 1996b; Fox *et al.*, 2000; and Fox *et al.*, 2002). Gulf sturgeon from the Suwannee River subpopulation are known to forage on brachiopods (Murie and Parkyn, pers. comm. 2002); however, this is not a documented prey item of other subpopulations. Ghost shrimp (*Lepidophthalmus louisianensis*) and the haustoriid amphipod (*Lepidactylus* spp.) are strongly suspected to be important prey for adult Gulf sturgeon over 1 m (3.3 ft) (Heard *et al.*, 2000; and Fox *et al.*, 2002). This hypothesis is based on the following evidence: (1) Gulf sturgeon have been consistently located and observed actively feeding in areas where numerous burrows similar to those occupied by ghost shrimp exist (Fox *et al.*, 2000) and in areas having a high density of ghost shrimp and haustoriid amphipods (Heard *et al.*, 2000), (2) the digestive tracts of two adult Gulf sturgeon that died during netting operations contained numerous ghost shrimp (Fox *et al.*, 2000), (3) stomach contents of a 30 kg (67 lb) sturgeon taken in the upper portion of

Choctawhatchee Bay contained more than 100 individual haustoriid amphipods and 67 ghost shrimp (Heard *et al.*, 2000), and (4) approximately one-third of 157 sturgeon guts analyzed by Carr *et al.* (1996b) contained exclusively brachiopods and ghost shrimp.

Reproduction

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age (Huff, 1975). Age at sexual maturity for females ranges from 8 to 17 years, and for males from 7 to 21 years (Huff, 1975). Gulf sturgeon eggs are demersal (they are heavy and sink to the bottom), adhesive, and vary in color from gray to brown to black (Vladykov and Greeley, 1963; Huff, 1975; and Parauka *et al.*, 1991). Chapman *et al.* (1993) estimated that mature female Gulf sturgeon weighing between 29 and 51 kg (64 and 112 lb) produce an average of 400,000 eggs. Habitat at egg collection sites consists of one or more of the following: limestone bluffs and outcroppings, cobble, limestone bedrock covered with gravel and small cobble, gravel, and sand (Marchant and Shutters, 1996; Sulak and Clugston, 1999; Heise *et al.*, 1999a; Fox *et al.*, 2000; and Craft *et al.*, 2001). On the Suwannee River, Sulak and Clugston (1999) suggest a dense matrix of gravel or cobble is likely essential for Gulf sturgeon egg adhesion and the sheltering of the yolk sac larvae, and is a habitat spawning adults apparently select. Other substrates identified as possible spawning habitat include marl (clay with substantial calcium carbonate), soapstone, or hard clay (W. Slack, Mississippi Museum of Natural Science (MMNS), pers. comm. 2002; and F. Parauka, pers. comm. 2002). Water depths at egg collection sites ranged from 1.4 to 7.9 m (4.6 to 26 ft), with temperatures ranging from 18.2 to 23.9 degrees Celsius (°C) (64.8 to 75.0 degrees Fahrenheit (°F)) (Fox *et al.*, 2000; Ross *et al.*, 2000; Craft *et al.*, 2001). Laboratory experiments indicated optimal water temperature for survival of Gulf sturgeon larvae is between 15 and 20 °C (59 and 68 °F), with low tolerance to temperatures above 25 °C (77 °F) (Chapman and Carr, 1995). Researchers hypothesize that spawning must take place where the hydrological and chemical settings are appropriate for gamete (mature reproductive cell) function, and temperature, pH, and dissolved oxygen conditions are stable and appropriate for embryonic and yolk sac larval development (Sulak and Clugston, 1999).

Sulak and Clugston (1999) suggested that sturgeon spawning activity in the Suwannee River is related to the phase