

ENVIRONMENTAL SETTING

The Navajo Nation consists of over 24,000 mi² (62,160 km²) of land and over 18 mi² (46.6 km²) of surface water bodies (U.S. Census Bureau 2001). Surface-water and fish samples were collected from four Navajo Nation lakes that are used either for fishing (Figure 2) or by foraging bald eagles. These sites were selected through consultation with the Navajo Nation EPA and the Navajo Nation Natural Heritage Program's Department of Fish and Wildlife. The four lakes sampled (Figure 1 and Figure 2) for this study included:

- 1) Asaayi Lake, a coldwater lake;
- 2) Morgan Lake, a warmwater lake;
- 3) Red Lake, a warmwater lake; and,
- 4) Wheatfields Lake, a coldwater lake;

Asaayi Lake Setting

Asaayi Lake (Figure 3, Figure 4) is a 35.5-acre (0.1 km²) lake located approximately 15 mi (24.1 km) southwest of Naschitti, New Mexico (Figure 1). This coldwater lake is found in the foothills of the Chuska Mountains at 7,562 ft (2.3 km) and has a maximum depth of approximately 25 ft (0.01 km). The area is characterized by mixed grasses, chaparral brush, oak-juniper woodland, piñon-juniper woodland and with occasional open forests of ponderosa pine. The shoreline is generally stable with some sloughing, but is mostly barren sand with only patchy grasses.

The most common large wild mammal in this area is mule deer. Mammalian predators include mountain lions, coyotes, and bobcats. Small mammals include deer mouse, porcupine, golden-mantled ground squirrel, Colorado chipmunk, wood rat, pocket gopher, Albert squirrel, and cottontail. Some of the more common birds are olive warbler, mountain bluebird, white-breasted nuthatch, Mexican junco, Steller's jay, red-shafted flicker and Rocky Mountain sapsucker.

Morgan Lake Setting

Morgan Lake (Figure 5) and the Four Corners Power Plant (Figure 6) are located on the Navajo Nation approximately 15 mi (24.1 km) southwest of Farmington, New Mexico (Figure 1). Morgan Lake encompasses approximately 1,287 surface acres (5.2 km²) and has a maximum storage capacity of 39,000 acre-feet (4.8×10^7 m³) of water. Water level is maintained by pumping from the San Juan River, a distance of 2 ½ mi (4.0 km). The maximum depth was about 100 feet (0.03 km) in 1966 (Sanchez 1972). The surrounding area is characterized by arid grasslands, but short grasses seldom cover the ground completely, leaving many areas bare with scattered shrubs. Xeric shrubs often grow in open stands among the grasses and sagebrush is dominant over extensive areas. Riparian shrubs and emergent wetland plants line and stabilize the edge of this lake.

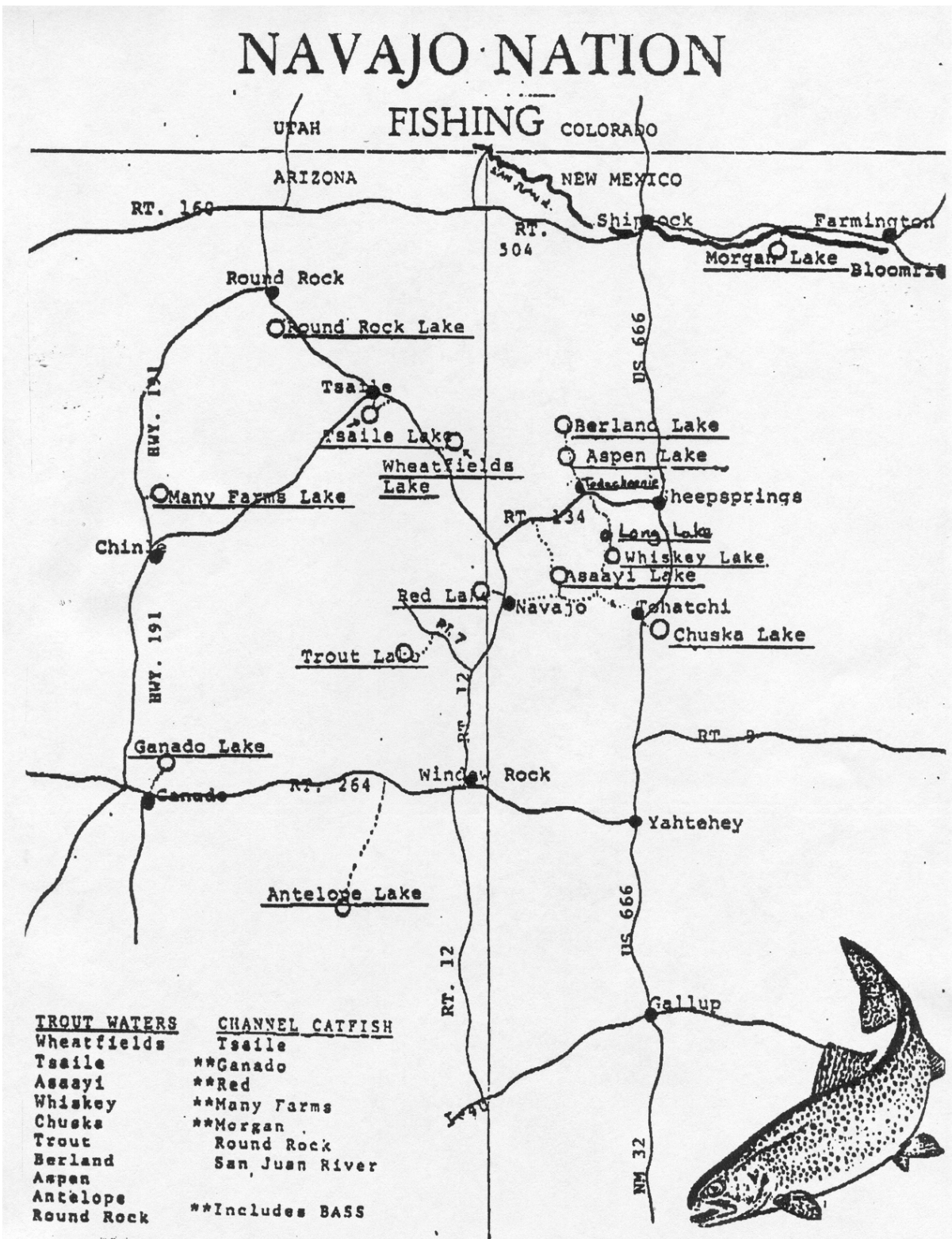


Figure 2. Location of Recreational Fishing Lakes on the Navajo Nation.
 (Source: Navajo Nation Department of Fish and Wildlife)

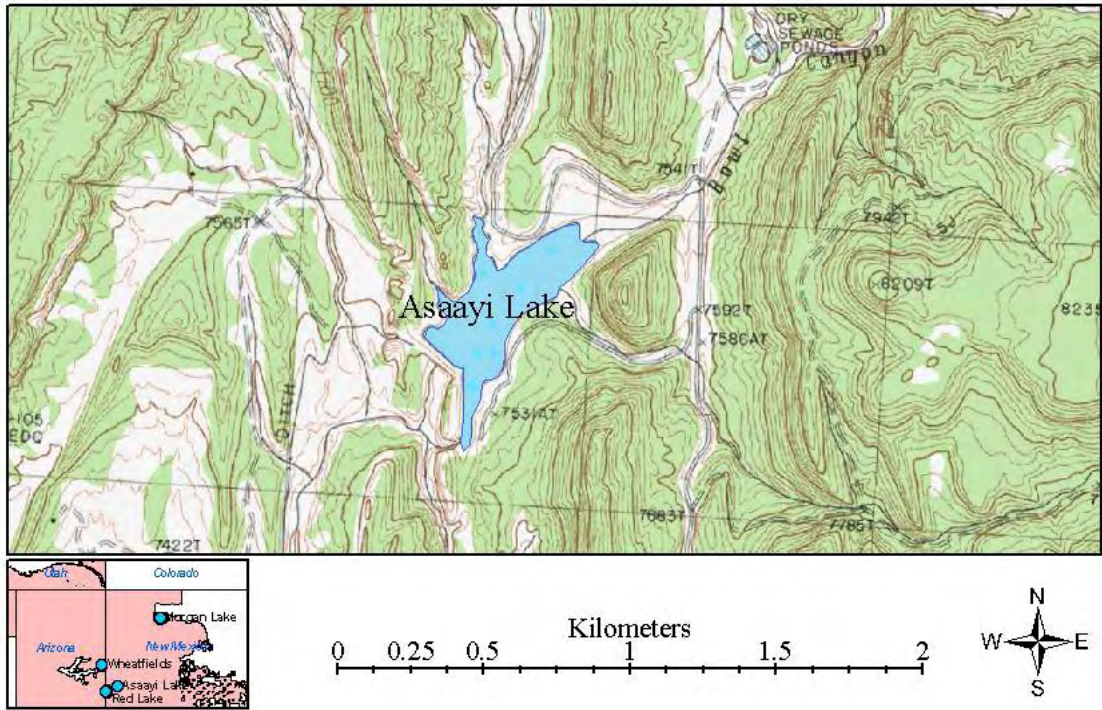


Figure 3. Location of Asaayi Lake on the Navajo Nation.



Figure 4. View of Asaayi Lake.

Photo: Joel D. Lusk

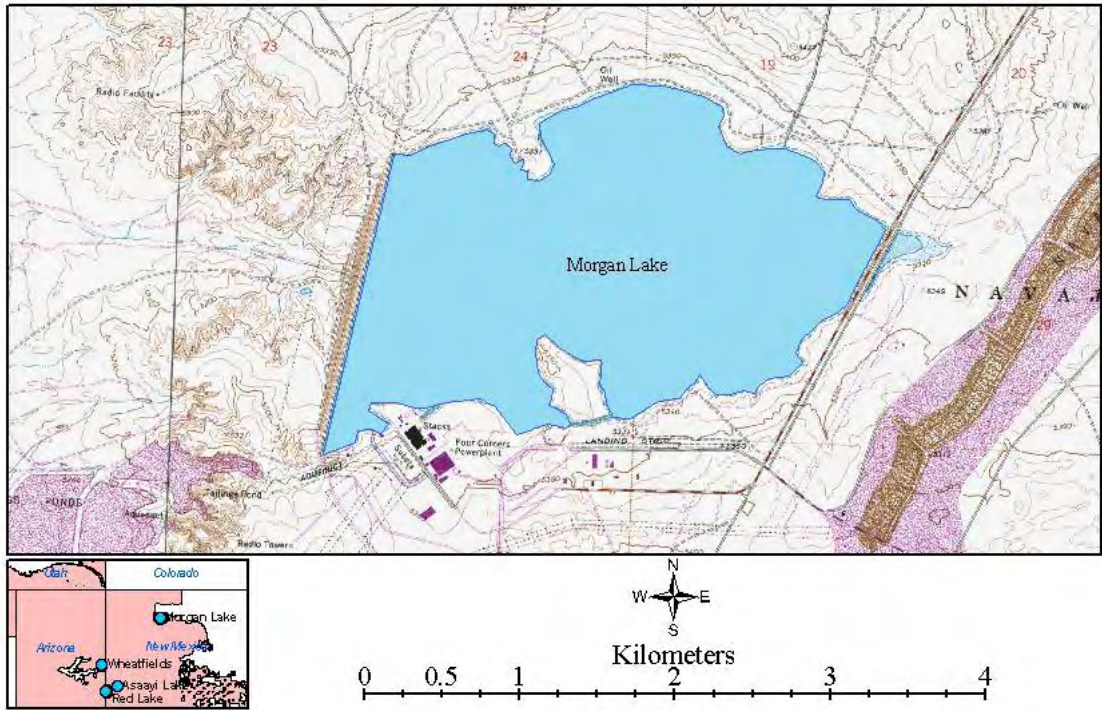


Figure 5. Location of Morgan Lake on the Navajo Nation.



Figure 6. View of Morgan Lake and the Four Corners Power Plant.

Photo: Joel D. Lusk

Morgan Lake is near the Fruitland Formation coal reserves that are mined for power generation. Morgan Lake was built in 1961 by the Arizona Public Service Company. It serves the Four Corners Power Plant, which is the 10th largest power plant in the country (R. Clifford, Arizona Public Service Company, written communication, 1996). Electrical power is produced at the power plant by burning over 8 million tons (~7,260 kg) of coal per year to produce heat; this in turn is transformed into steam that turns the generators to produce electricity. This process requires an adequate supply of water as a cooling source for the power plant. In 1960, an agreement between the owners and the Navajo Nation established the use of Morgan Lake for recreation and various fish were stocked in 1962 (Sanchez 1972).

Previous Morgan Lake Studies

There have been several investigations into the quality of water or fish collected from Morgan Lake (Sanchez 1972, 1973; Blinn *et al.* 1976, Westinghouse Electric Corporation 1975; Geotz and Abeyta 1987; USFWS 1988; Esplain 1995, Bristol *et al.* 1997; and this study). Sanchez (1972) reported on the quality of water, sediment and invertebrates collected from 1966 to 1972. In 1973, a fish kill occurred during August 10 through 17, 1973. An estimated 33,674 fish ranging in total length from 5 to 24 inches (127 to 609 mm) were lost during the die-off (Sanchez 1973). A blue-green algal bloom and high surface water temperatures (32.2 to 40C) were thought to be contributing factors. In 1975, the Northern Arizona University was contracted to evaluate the probable causes of previous fish kills in the lake (Blinn *et al.* 1976). Blinn *et al.* (1976) identified the relationship between blue-green (Cyanophyta) algal blooms, elevated water temperatures, early summer warming, and anoxic conditions. Westinghouse Electric Corporation (1975) also reported on the quality of Morgan Lake fish collected during 1973 and 1975. Management of the lake was changed to reduce the potential for frequent fish kills.

The temporal and spatial water quality trends in Morgan Lake from 1973 through 1980 were described by Geotz and Abeyta (1987). Specific conductance, hydrogen potential (pH), orthophosphate, sodium, sulfate, iron, and manganese concentrations were reviewed for trends. During this period, specific conductance, sodium, and sulfate concentrations in Morgan Lake decreased significantly. The USFWS (1988) reported on the quality of fish collected in 1986. Concerns about onsite spills, including a spill of hydrazine in 1991, triggered additional monitoring of water and fish quality during a multi-agency investigation (Esplain 1995). Esplain (1995) reported on the quality of ground water, surface water, soils, and sediment from Morgan Lake and its surroundings. Clifford (1996) summarized water quality data for Morgan Lake collected from 1992 to 1996. Bristol *et al.* (1997) also reported on the quality of fish fillets and whole fish collected from Morgan Lake in 1993 as well as the potential acute health risks posed to both people and piscivorous birds.

Red Lake Setting

Red Lake (Figure 7, Figure 8) is a 611-acre (2.5 km²) lake located approximately 22 mi (35.4 km) southwest of Naschitti, New Mexico (Figure 1). This warmwater lake is found at an elevation of 7,150 ft (2.2 km) within the Red Valley and has a maximum depth of approximately 5 ft (0.002 km). The area is characterized by mixed grasses, herbs, chaparral brush, sagebrush, with scattered two-needle, piñon pine and several species of juniper. The

shoreline is generally stable with some sloughing, but two areas to the north and east have extensive cattail and willow stands.

Major mammals are mule deer, mountain lion, coyote, and bobcat. Smaller species include blacktail jackrabbit, Colorado chipmunk, rock squirrel, wood rat, white-footed mouse, cliff chipmunk, cottontail, porcupine, skunk, and gray fox. Resident birds include bushtit, piñon jay, plain titmouse, black-chinned hummingbird, Woodhouse's jay, red-tailed hawk, red-shafted flicker, and rock wren. Bald eagles have been observed feeding on catfish and waterfowl from this lake extensively (G. Tom, Navajo Nation Fish and Wildlife Department, written communication, 1999).

Wheatfields Lake Setting

Wheatfields Lake (Figure 9, Figure 10) is a 226-acre (0.91 km²) lake located approximately 22 mi (35.4 km) southwest of Newcomb, New Mexico (Figure 1). This coldwater lake is found in the foothills of the Chuska Mountains at 7,304 ft (2.2 km) and has a maximum depth of approximately 18 ft (0.01 km). The area is characterized by mixed grasses, chaparral brush, oak-juniper woodland, piñon-juniper woodland and with occasional open forests of ponderosa pine. The shoreline is generally bare and stable with some sloughing.

The most common large mammal in this area is mule deer. Mammalian predators include mountain lions, coyotes, and bobcats. Small mammals include deer mouse, porcupine, golden-mantled ground squirrel, Colorado chipmunk, wood rat, pocket gopher, Albert squirrel, and cottontail. Some of the more common birds are olive warbler, mountain bluebird, white-breasted nuthatch, Mexican junco, Steller's jay, red-shafted flicker and the Rocky Mountain sapsucker.

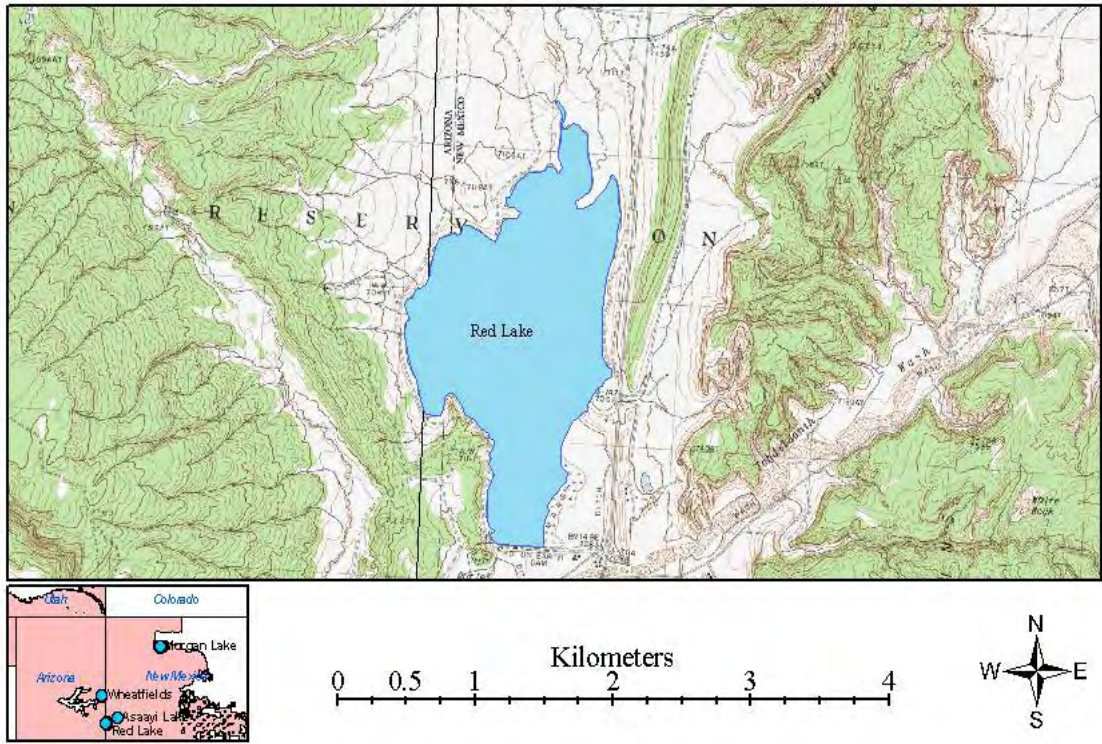


Figure 7. Location of Red Lake on the Navajo Nation.



Figure 8. View of Red Lake.

Photo: Joel D. Lusk

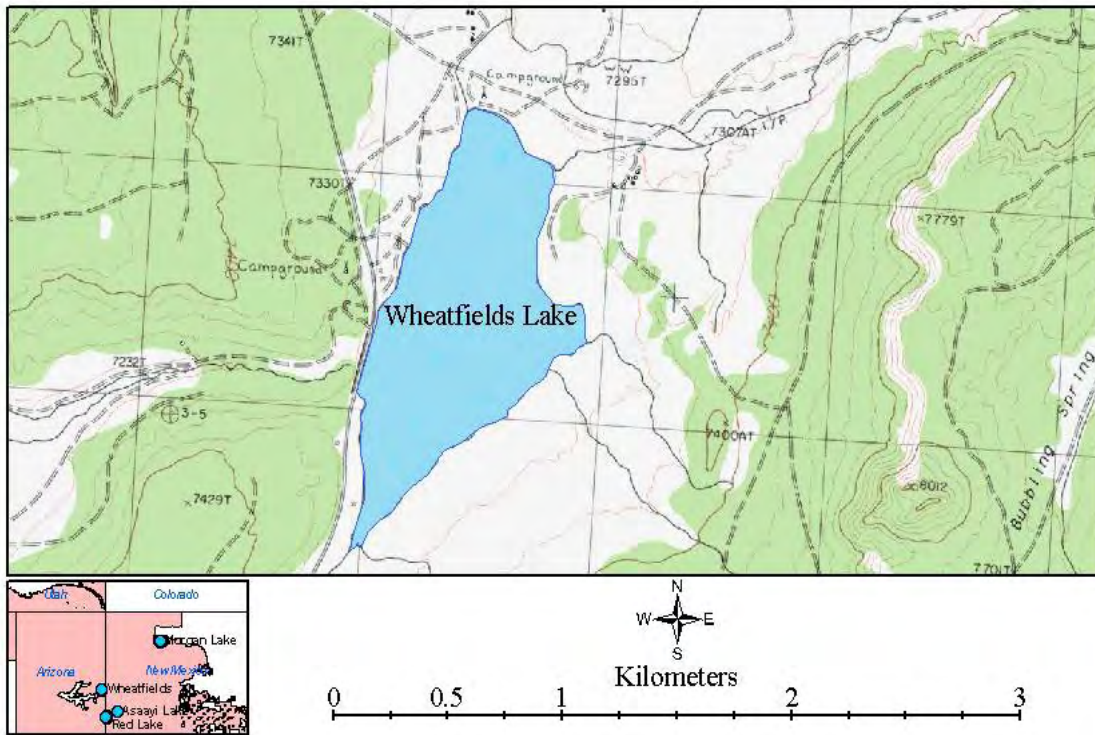


Figure 9. Location of Wheatfields Lake on the Navajo Nation.



Figure 10. View of Wheatfields Lake.

Photo: Joel D. Lusk