

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL, A LARGE OLIGOTROPHIC RESERVOIR ON THE COLORADO RIVER, UTAH AND ARIZONA

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ABSTRACT: We conducted monthly boat surveys of aquatic birds on Lake Powell from September to April each year from 1994 to 1997. The surveys were standardized in seven designated areas on the reservoir. Each survey took three days and was done by two experienced birders and a boat pilot. In all, we recorded 72,549 detections of 57 species on 19 monthly surveys. The most commonly detected species was the American Coot, followed by the Western Grebe; these two species accounted for 81% of all detections. Species rarely recorded in southern Utah and northern Arizona but found on the surveys included the Little Blue Heron, Barrow's Goldeneye, Greater Scaup, Herring Gull, Long-tailed Duck, Red-necked Grebe, Surf Scoter, and Pacific and Yellow-billed Loons. Species rarely recorded in winter for southern Utah and northern Arizona but detected on the surveys included the American White Pelican, Hooded Merganser, and Red-breasted Merganser. Lake Powell appears to be used primarily as a migratory stopover for aquatic species. Reservoir levels fluctuate greatly from year to year, preventing the growth of aquatic vegetation. Fish populations in the lake also fluctuate, and only in some years are sufficient to support winter populations of fish-eating species.

The widespread construction of dams for power generation and flood control throughout the world in the 20th century has created open-water habitats that in many regions had been lacking. These newly created habitats have been colonized by a variety of aquatic bird species (e.g., Rahmani 1989, Pandey 1993, Tremblay 1993, Su and Liu 1995, Rizzo and Patrizia 1999, Utschick 1998, 2000). Surprisingly little is known, however, about how reservoirs have affected the population sizes, migration patterns, or breeding distributions of aquatic species. To date, most studies in North America have focused on waterfowl use of particular food resources and associated habitats in reservoirs (e.g., McKnight and Hepp 1995, Benedict and Hepp 2000). In particular, despite the construction of numerous dams in the western U.S., little work has been done on waterbird colonization and use of reservoirs in the more arid regions of the southwestern U.S., over most of which large bodies of open water were absent from the end of the Pleistocene Epoch until the 20th century (Rosenberg et al. 1991, McCaw et al. 1996).

The construction of Glen Canyon Dam and the subsequent filling of Lake Powell in the southwestern U.S. created a large deep-water reservoir on the central Colorado Plateau (Figure 1). The dam was completed in 1963 and the lake began filling in 1964, reaching full pool in 1980. The reservoir covers 67,900 hectares (679 km²) when at full-pool elevation of 1128 meters. Lake habitats have been in existence for 38 years. Since the dam was completed, a variety of aquatic bird species previously rare or unknown from the Colorado River region have been recorded on the reservoir.

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

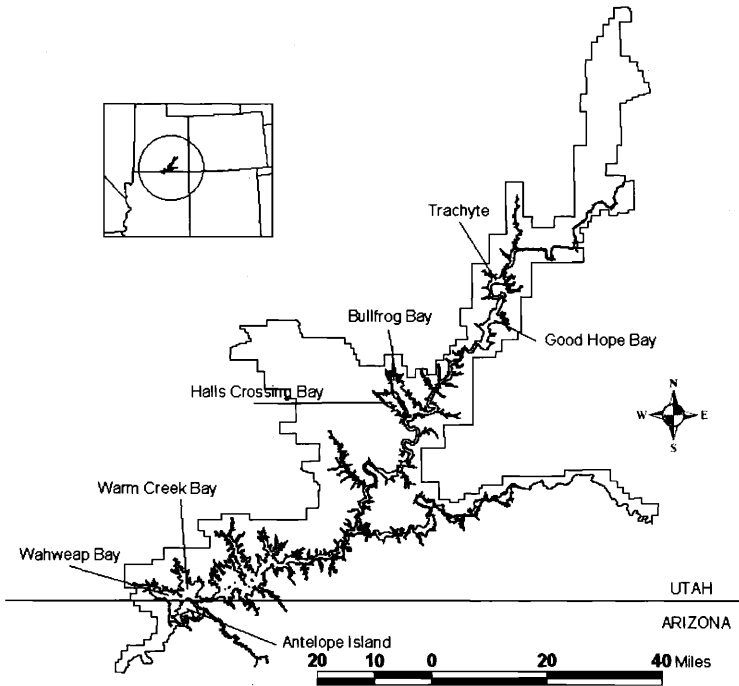


Figure 1. Seven sampling areas surveyed consistently throughout the survey period, 1994–1997. From south to north, the locations are Antelope Island, Wahweap Bay, Warm Creek Bay, Hall's Creek Bay, Bullfrog Bay, Good Hope Bay, and Trachyte.

Through 2001, 82 species of aquatic birds (see definition below) have been recorded on Lake Powell (LaRue et al. 2001), some in large numbers.

The Colorado River was originally a dynamic sediment-laden river with peak flows during spring flooding and minimum flows during the winter (Carothers and Brown 1991). Spring floods scoured out the river channel, preventing the establishment of aquatic vegetation. Primary productivity was low because of poor light penetration in the muddy waters. Early accounts indicate that few aquatic species occurred along the Colorado River prior to the construction of the many dams now regulating its flow (Behle and Higgins 1958, Carothers and Brown 1991, Rosenberg et al. 1991).

Grinnell (1914) conducted wildlife surveys along the lower Colorado River downstream of Needles in 1910 and noted only a few American Coots and dabbling ducks. The situation today is very different. The construction of large dams on the Colorado River created habitat for waterfowl and other aquatic species both above and below the dams. Hoover Dam was the first to be completed in 1936, creating Lake Mead. Other dams were soon built

downstream (Parker, Imperial, and Davis). The general effects of these dams have been to increase both wintering and breeding habitat for aquatic avifauna greatly (Rosenberg et al. 1991, Stevens et al. 1997). The clear cold waters below the dams create conditions conducive to the growth of aquatic vegetation, supporting large wintering populations of waterfowl. The deep reservoirs above the dams provide wintering habitat for a variety of aquatic birds, especially diving species such as grebes.

Prior to 1994, only two surveys had been completed on Lake Powell, and no systematic long-term winter surveys had been initiated. In January 1988 a lakewide survey was conducted, documenting 3715 individuals of 21 species (National Park Service data). In November 1992 a lakewide survey for the Western Grebe (no distinction was made between the two species of *Aechmophorus*) yielded 3619 individuals (National Park Service data). In February 1994 a survey in Warm Creek Bay revealed three species of loons, the Common, Pacific, and Yellow-billed. The Yellow-billed Loon was the second recorded in Utah.

In May 1994 the Resource Management Division of Glen Canyon National Recreation Area acquired a 32-foot Munson Hammerhead with a cruising radius of 10-12 hours. This boat offered ample speed, a stable platform for spotting scopes, and an enclosed cabin for winter survey work. Because of the lack of baseline data on wintering aquatic bird populations on Lake Powell, we initiated a systematic survey program in October 1994, continuing it through April 1997. This report documents the results of the three years of surveys. The primary goal of the program was to inventory selected areas on Lake Powell on a monthly basis to determine the numbers and kinds of migrant and overwintering aquatic birds.

SURVEY METHODS

We chose to use boat surveys for the project primarily because rare species are more likely to be detected and identified from boat surveys than from aerial surveys (cf. Stancill and Leslie 1990). Preliminary observations by boat and fixed-wing plane located areas of Lake Powell with significant concentrations of birds. On the basis of these observations, earlier reports, and the logistics of operating on a lake 295 km long, we designated seven areas for monthly surveys: Trachyte Canyon, Good Hope Bay, Bullfrog Bay, Hall's Creek Bay, Warm Creek Bay, Wahweap Bay, and Antelope Island (Figure 1). Antelope Island is in Arizona, while the other six survey areas are in Utah. No main channel reaches or narrow side canyons were included in the designated survey routes because few birds were seen in these areas.

Once a month between September and April, we conducted a three-day survey, starting at Good Hope Bay and Trachyte Creek on day 1, moving to Bullfrog and Hall's Creek bays on day 2, and ending at Warm Creek and Wahweap bays and Antelope Island on day 3. Fixed routes were followed along the shorelines of these seven survey areas. Most birds seen were individually identified and counted. Large rafts of Western Grebes and American Coots were occasionally encountered, however, and in some cases numbers had to be estimated. In these cases, two observers indepen-

dently estimated numbers, with an average taken where estimates were close (within 10%). If the estimates were different by more than 10%, then new counts were made until the estimates converged. We attempted to avoid double-counting individuals as a result of their movements. The counts reported in this paper are thus conservative. One assumption was that birds counted on different days did not move between survey areas over night. In general we made no attempt to distinguish between Clark's and Western Grebes in large rafts. We made occasional checks, however, to determine the percentage of Clark's and to document its presence on Lake Powell. In these checks the number of Clark's Grebe was always <1% of the flock number.

Data recorded for each bird or flock observed included location, time of day, species, habitat, behavior, and, where possible, sex and age. Incidental observations of birds were recorded while we were moving between designated survey areas but were not included in total numbers. Aquatic birds are defined as all members of the following: all families from Gaviidae through Anatidae and all families from Rallidae through Laridae (AOU 1998 sequence).

We determined the principal means of foraging on Lake Powell for each species, assigning it to one of four foraging guilds: aerialists (gulls, terns), dabblers (dabbling ducks), divers (diving ducks, coots, grebes, loons, cormorants, etc.), and waders (shorebirds, herons, etc.). Monthly surveys were conducted by two experienced bird observers. Because of stormy weather, boat problems, and government shutdowns, surveys were not conducted in November 1995 and October and December 1997. Partial surveys were conducted in March and April 1996, with only southern lake areas (Wahweap and Warm Creek bays, Antelope Island) surveyed. Seasons were defined as fall (September–November), winter (December–February), and spring (March–April).

RESULTS AND DISCUSSION

Between October 1994 and April 1997, 117 surveys over 19 months detected 57 species of aquatic birds in the seven survey areas. This figure represents 81% of the 70 aquatic species known from the reservoir by 1997. The two most common wintering species on Lake Powell were the American Coot and Western Grebe. These two species accounted for 81% of all recorded individuals (48% and 33% respectively). Other species with at least 1% of the total number recorded were the Gadwall (2.4%), Green-winged Teal (1.7%), Ring-billed Gull (1.5%), Common Goldeneye (1.3%), and Redhead (1.1%).

Several species rarely reported in Arizona and southern Utah were recorded during the surveys. These include the Little Blue Heron, Barrow's Goldeneye, Greater Scaup, Herring Gull, Long-tailed Duck, Pacific Loon, Red-necked Grebe, Surf Scoter, Wood Duck, and Yellow-billed Loon. Unusual winter (December–February) records were obtained for several additional species, including the American White Pelican, Hooded Merganser, and Red-breasted Merganser.

Surveys prior to 1960 had recorded 24 species of aquatic birds along the Colorado River and its main tributaries from the Glen Canyon Dam site to Hite (Table 1; Woodward 1958, Behle and Higgins 1959, Behle 1960). Between 1960 and 1963 an additional 12 species were recorded in the area, primarily near the dam site (National Park Service files). Since 1964 an additional 44 species have been recorded, the most recent being the first record of the Yellow-footed Gull for Utah and Arizona. The bird, an adult, was discovered on 21 April 1999 in Wahweap Bay in Utah and then relocated later the same day near Antelope Island in Arizona (Rosenberg and Benesh 1999).

Because far more people, including birders and government biologists, have been visiting the region since the completion of Glen Canyon Dam, the large increase in number of species in the last 30 years may be more a reflection of number of observers rather than actual “discovery” of the reservoir by aquatic species. Earlier surveys and visitors were few, and most were during the spring and summer months when the Colorado River was most easily run. It is thus likely that some of the species recorded since 1964 may have occurred in the region earlier but went unrecorded.

The two most common habitats in which birds were recorded were drowned tamarisk (*Tamarix ramosissima*) in shallow water near shore and large shallow bays of open water. Very few birds were seen along the rocky shorelines that constitute >90% of Lake Powell’s margin. The American Coot, other diving species, and the majority of the dabbling ducks were associated with drowned tamarisk. Growth of algae and in some cases aquatic vascular plants, with their associated invertebrates along with small fish, presumably provide the primary food for these species. In the larger shallow bays such as Warm Creek or Hall’s Creek bays (Figure 2) were the large concentrations of Western Grebes. These birds were often seen diving for food, most likely schools of small fish such as the threadfin shad (*Dorosoma petenense*).

Lake Powell provides relatively poor habitat for dabbling ducks. Because of fluctuations in reservoir levels of 10 to 15 meters per year, extensive aquatic vegetation cannot develop. Rather, a thin layer of algae, primarily *Chara*, attached to boulders and drowned tamarisk stems, provides the only food for dabblers. Recently, however, the exotic aquatic vascular plant *Najas marina* has appeared in the reservoir and is spreading rapidly along beaches. The ability of this species to provide food for dabblers in the fluctuating reservoir remains unknown. In general, most dabblers peak in fall and spring migration, and only a few hundred typically winter on Lake Powell.

The abundance of fish-eating diving species such as grebes, cormorants, loons, and mergansers varied greatly from year to year. Counts of the Western Grebe, the most common fish-eating diving species on the reservoir, were high when numbers of small fish in Lake Powell were high (unpublished National Park Service data). Counts of the Western Grebe on Lake Powell, however, rarely exceeded 5000 individuals, well below numbers known from natural lakes. In years when fish numbers were low, relatively few diving species lingered past December. It is perhaps significant

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

Table 1 Water Birds Detected 1994–1997 on Lake Powell, Glen Canyon National Recreation Area, Utah and Arizona

Species	Pre-dam presence ^a	Number of detections	Percentage of surveys detected
Pacific Loon <i>Gavia pacifica</i>		7	26
Common Loon <i>Gavia immer</i>		109	95
Yellow-billed Loon <i>Gavia adamsii</i>		5	26
Pied-billed Grebe <i>Podilymbus podiceps</i>	X	377	100
Horned Grebe <i>Podiceps auritus</i>		92	58)
Red-necked Grebe <i>Podiceps grisegena</i>	X	3	16
Eared Grebe <i>Podiceps nigricollis</i>	X	636	100
Western Grebe <i>Aechmophorus occidentalis</i>		23,712	100
Clark's Grebe <i>Aechmophorus clarkii</i>		17	42
American White Pelican <i>Pelecanus erythrorhynchos</i>	X	9	21
Double-crested Cormorant <i>Phalacrocorax auritus</i>	X	547	89
Great Blue Heron <i>Ardea herodias</i>	X	138	95
Great Egret <i>Ardea alba</i>	X	2	11
Snowy Egret <i>Egretta thula</i>	X	2	11
Little Blue Heron <i>Egretta thula</i>		1	5
Cattle Egret <i>Bubulcus ibis</i>		2	5
Black-crowned Night-Heron <i>Nycticorax nycticorax</i>	X	2	5
White-faced Ibis <i>Plegadis chihi</i>	X	107	11
Canada Goose <i>Branta canadensis</i>	X	166	79
Snow Goose <i>Chen caerulescens</i>		1	5
Wood Duck <i>Aix sponsa</i>		1	5
Gadwall <i>Anas strepera</i>	X	1764	100
American Wigeon <i>Anas americana</i>	X	183	63
Mallard <i>Anas platyrhynchos</i>	X	534	95
Blue-winged Teal <i>Anas discors</i>	X	58	11
Cinammon Teal <i>Anas cyanoptera</i>	X	67	32
Northern Shoveler <i>Anas clypeata</i>	X	323	79
Northern Pintail <i>Anus acuta</i>	X	588	79
Green-winged Teal <i>Anas carolinensis</i>	X	1270	84
Redhead <i>Aythya americana</i>	X	822	89
Ring-necked Duck <i>Aythya collaris</i>		719	63
Greater Scaup <i>Aythya marila</i>		6	11
Lesser Scaup <i>Aythya affinis</i>	X	654	84
Surf Scoter <i>Melanitta perspicillata</i>		2	11
Long-tailed Duck <i>Clangula hyemalis</i>		4	21
Bufflehead <i>Bucephala albeola</i>	X	515	84
Common Goldeneye <i>Bucephala clangula</i>	X	970	74
Barrow's Goldeneye <i>Bucephala islandica</i>		10	11
Hooded Merganser <i>Lophodytes cucullatus</i>		31	32
Common Merganser <i>Mergus merganser</i>	X	733	95
Red-breasted Merganser <i>Mergus serrator</i>		168	68
Ruddy Duck <i>Oxyura jamaicensis</i>	X	303	74
American Coot <i>Fulica americana</i>	X	34,985	100
Killdeer <i>Charadrius vociferus</i>	X	4	11

(continued)

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

Table 1 (Continued)

Species	Pre-dam presence ^a	Number of detections	Percentage of surveys detected
American Avocet <i>Recurvirostra americana</i>	X	13	11
Greater Yellowlegs <i>Tringa melanoleuca</i>		5	11
Lesser Yellowlegs <i>Tringa flavipes</i>		3	11
Long-billed Curlew <i>Numenius americanus</i>		6	5
Willet <i>Catoptrophorus semipalmatus</i>		22	11
Marbled Godwit <i>Limosa fedoa</i>		218	16
Franklin's Gull <i>Larus pipixcan</i>	X	80	16
Bonaparte's Gull <i>Larus philadelphia</i>		2	5
Mew Gull <i>Larus canus</i>		1	5
Ring-billed Gull <i>Larus delawarensis</i>	X	1124	100
California Gull <i>Larus californicus</i>	X	418	58
Herring Gull <i>Larus argentatus</i>		4	21
Forster's Tern <i>Sterna forsteri</i>		4	5

^aSpecies recorded in area prior to building of Glen Canyon Dam.

that the most common wintering species on Lake Powell was the American Coot, a generalist that has a broad array of foraging behaviors.

Because of the timing of the surveys, some species groups were not detected in this study. Regionally, the bulk of fall shorebird migration takes place in August and September, and we conducted relatively few surveys in September. The only survey month that yielded good numbers of shorebirds was April, when flocks of Marbled Godwits were often found. Because of the shoreline of Lake Powell is so long (about 2000 miles at full-pool elevation) it is likely that many shorebirds were missed simply because of the amount of available habitat. Other groups not well represented in the survey data include phalaropes, terns, jaegers, and Sabine's Gull. Wilson's and Red-necked Phalaropes tend to migrate through the region in a short interval of a week or so in late March (National Park Service files), and none of the surveys in that month apparently coincided with this window. In fall, these species tend to be more diffuse in their migration, and also typically move through in the largest numbers in late August. Most tern species migrate through the Lake Powell area in May or August and were also missed because of the survey times. Jaegers are extremely rare in the region for unknown reasons, with only a single documented sighting of an adult Parasitic Jaeger over Wahweap Bay on 21 September 2000 (LaRue et al. 2001). Finally, Sabine's Gull moves through the Lake Powell region in very small numbers (four records of 10 individuals) during a short period between about 18 and 25 September (LaRue et al. 2001) and was missed on the 1994–1997 surveys.

The results presented in this paper are similar to survey results at reservoirs in the lower Colorado River Valley such as Lake Havasu and Mohave Lake (Rosenberg et al. 1991). The relative abundance of the species in the two areas is similar, but many more birds winter in the lower

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL



Figure 2. Drowned Fremont Cottonwood (*Populus fremontii*) in upper Hall's Creek Bay, 29 November 1994. This area consistently supports high numbers and diversity of aquatic birds, including most of the wintering population of Double-crested Cormorants on Lake Powell.

Photo by J. D. Grahame/National Park Service

valley than on Lake Powell. This difference is probably due to a combination of milder winters, a greater amount of food and other resources in the older reservoirs, and adjacent wildlife refuges and non-dammed segments of the Colorado River. One major difference between the two regions is that Clark's Grebe is very rare on Lake Powell but common in the lower valley (Rosenberg et al. 1991). It is fairly common on Lake Mead as well (Spence pers. obs.). Reasons for this difference are unknown but may be related to different migration patterns of the two species within the Intermountain West flyway.

ANNOTATED SPECIES LIST

The following list details our results for the 57 species seen in one or more of the seven designated survey areas during the 19 months of surveys. Table 1 summarizes the counts for each species.

Pacific Loon (*Gavia pacifica*). A rare migrant and possible winter resident. Seven records, of one in October 1994, two in October 1995, one in January 1996, two in November 1996, and one in April 1997. The species has been seen in all survey areas except Antelope Island and Good Hope Bay. There is a slight possibility for some of the early records to have been of the Arctic Loon, unrecorded inland in the western United States, although the last three individuals were carefully identified as the Pacific Loon.

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

Common Loon (*Gavia immer*). A rare but regular migrant and winter resident, with records from every survey month except September 1995. Peak numbers are recorded between December and February. The largest single count was five birds on Warm Creek Bay on 15 February 1996. Common Loons are generally solitary on Lake Powell.

Yellow-billed Loon (*Gavia adamsii*). A Yellow-billed Loon was first seen on 10 February 1994 on Warm Creek Bay prior to our launching the lake surveys. The bird associated with both Common and Pacific Loons. The second record was on 21 December 1994, again on Warm Creek Bay. The bird then moved to Wahweap Bay, where it was seen twice opposite the Coves, on 15 February and 15 March 1995. Very likely this same bird returned the next year, with sightings on Warm Creek Bay on 15 February and 15 March 1996.

Pied-billed Grebe (*Podilymbus podiceps*). An uncommon but regularly seen species, with records from all survey months. Numbers tend to peak in late fall and winter (November–January). A majority of the records are from 1994–95, when the species was particularly common on Lake Powell. The largest count was of 39 on Wahweap Bay in 20 January 1995.

Horned Grebe (*Podiceps auritus*). Prior to 1996–97 a rare fall and spring migrant, with only two winter records, of single birds on Good Hope Bay on 18 January 1995 and on Bullfrog Bay on 14 February 1996. For unknown reasons the species was relatively common on Lake Powell during 1996–97, with 84 detections that year compared with seven in 1994–95 and one in 1995–96. During the five months surveyed, counts included 16 in November, 10 in January, 11 in February, 29 in March, and 18 in April. The single largest count was of 12 birds around Antelope Island on 21 March 1997.

Red-necked Grebe (*Podiceps grisegena*). A rare winter and spring migrant, with three records of single birds, 20 January 1996 and 17 January 1997 on Warm Creek Bay and 21 March 1997 near Antelope Island. These are the first records for Glen Canyon National Recreation Area and Lake Powell.

Eared Grebe (*Podiceps nigricollis*). A common fall and uncommon spring migrant, often lingering in small numbers through the winter. The largest group seen during surveys was 168 on Wahweap Bay on 23 January 1997.

Western Grebe (*Aechmophorus occidentalis*). Common to abundant; the second most common species on Lake Powell during the survey period. Western Grebes generally occur in rafts ranging from a dozen up to 1700 at the mouth of Trachyte Creek on 20 November 1996. Traditionally, large numbers have been seen at this location, Good Hope Bay, and Bullfrog Bay. There is a strong gradient of increasing numbers from the dam toward Hite at the far northern end of the lake (National Park Service unpublished data). Peak numbers tend to occur in fall or early winter (October–December), coinciding with southbound migration. A smaller peak occurs in March and April as well. Large numbers were counted in fall and winter of 1995–96 and 1996–97, coinciding with relatively high populations of the threadfin shad.

Clark's Grebe (*Aechmophorus clarkii*). A rare migrant in spring (April) and fall (September–November). The occasional inspection of rafts of Western Grebes indicated that <1% of these flocks are Clark's. There is only one winter record, of one on Good Hope Bay on 18 January 1995. Generally this species occurs as single birds or more often pairs at the upper ends of bays, associated with drowned tamarisk.

American White Pelican (*Pelecanus erythrorhynchos*). Pelicans generally migrate through the area in August and were missed on the surveys. However, two birds lingered at Wahweap Bay from 20 October through 21 December 1994. A single bird was observed on Bullfrog Bay from 29 November 1994 to 19 January 1995.

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

Double-crested Cormorant (*Phalacrocorax auritus*). A common fall migrant and winter resident on some bays, especially Hall's Creek Bay. Numbers peak in fall and winter, and generally most birds are gone by March or April. The largest flock was of 41 on upper Hall's Creek Bay on 19 October 1994.

Great Blue Heron (*Ardea herodias*). A rare year-round resident, with migrants augmenting residents during the winter. The largest groups were of seven birds each at Bullfrog Bay on 14 March 1995 and Wahweap Bay on 14 March 1996.

Great Egret (*Ardea alba*). A very rare spring migrant, with two records. Single adults were seen along the shores of Wahweap Bay on 20 April 1995 and 12 April 1996.

Snowy Egret (*Egretta thula*). A rare spring migrant to the shores of Lake Powell, with only two records of single birds, at Bullfrog Bay on 14 March 1995 and Warm Creek Bay on 18 April 1997.

Little Blue Heron (*Egretta caerulea*). Extremely rare migrant, with a single record of an immature at upper Wahweap Bay on 21 September 1995.

Cattle Egret (*Bubulcus ibis*). Rare spring migrant. Two birds were seen along the shores of Wahweap Bay on 18 April 1997.

Black-crowned Night Heron (*Nycticorax nycticorax*). Rare migrant. Two birds were seen on 12 April 1996 in tamarisk at the head of Warm Creek Bay.

White-faced Ibis (*Plegadis chihi*). Small flocks occur regularly in April during northbound migration. These flocks often linger into May and early June in the Wahweap area. The largest flock was of 46 birds on 17 April 1997 at Bullfrog Bay.

Canada Goose (*Branta canadensis*). An uncommon fall and spring migrant on Lake Powell, generally not lingering in winter. The largest flock of 46 birds was seen on Warm Creek Bay on 21 March 1997. This species overwinters commonly at the Page sewage-treatment plant and the adjacent golf course.

Snow Goose (*Chen caerulescens*). Very rare winter visitor. A single bird was seen with a flock of American Coots off Antelope Island on 6 December 1995.

Wood Duck (*Aix sponsa*). A very rare winter visitor, with a single record of a male that remained at Bullfrog Marina from November 1994 to February 1995 (Figure 3).

Gadwall (*Anas strepera*). A common species, seen in all survey months. Numbers peak in winter and early spring (especially March) during migration. The largest flock was of 103 birds on Hall's Creek Bay on 19 January 1996.

American Wigeon (*Anas americana*). An uncommon species, generally seen only in fall (October) and spring (March) migration. Large flocks of this species overwinter regularly on golf courses at Page, so apparently the lake does not provide proper foraging habitat for wigeons. The largest flock was of 42 birds on Warm Creek Bay on 15 March 1995.

Mallard (*Anas platyrhynchos*). An uncommon resident and common wintering species, encountered in small flocks in most survey areas, with peak numbers in December and January. Mallards were scarce in the winter of 1995–96. The largest flock was of 56 birds on Hall's Creek Bay on 29 November 1994.

Blue-winged Teal (*Anas discors*). An uncommon migrant in the Lake Powell area, with only a few sightings of small flocks in September and October 1995. The largest flock was of 30 on Wahweap Bay on 20 October 1995. Because of difficulties in distinguishing birds in eclipse plumage, some teal seen during the study were left unidentified and could have been either this species or the Cinnamon Teal.

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL



Figure 3. Male Wood Duck at Bullfrog Marina. 20 December 1994. This bird stayed most of the winter 1994–1995 and became extremely tame.

Photo by J. R. Spence/National Park Service

Cinnamon Teal (*Anas cyanoptera*). A rare spring (March–April) and early fall (September) migrant, with few birds detected prior to 1997. In 1997 small flocks were seen in scattered locations, with the largest being 10 on Warm Creek Bay on 21 March 1997 and 14 on Wahweap Bay on 18 April 1997.

Northern Shoveler (*Anas clypeata*). An uncommon migrant and winter resident, scarce in 1995–96. Relatively large numbers were seen in spring of 1997, with 91 in March and 189 in April. The largest flock was of 90 birds at the mouth of Trachyte Creek on 16 April 1997.

Northern Pintail (*Anas acuta*). An uncommon fall and spring migrant and winter resident, scarce in 1995–96. Relatively large numbers were seen in late winter 1997, with 255 birds on Wahweap Bay and 185 on Warm Creek Bay on 21 February 1997.

Green-winged Teal (*Anas crecca*). An uncommon fall and early spring migrant, with peak numbers in October, February, and March. A few birds linger through the winter. The largest flocks were seen on 21 March 1997, with 165 around Antelope Island and 152 on Wahweap Bay.

Redhead (*Aythya americana*). Common migrant and winter resident. Birds start appearing in October and peak in December–January. A few linger into April. Redhead numbers peaked on 21 December 1994 and 20 January 1995, when flocks of 191 and 175, respectively, were seen on Wahweap Bay. Numbers of Redheads were very low in 1995–96, while more were seen in 1996–97, including a flock of 164 on Warm Creek Bay on 23 January 1997.

Ring-necked Duck (*Aythya collaris*). Common migrant and winter resident, with numbers peaking in December and January. Like other waterfowl, this species was

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

scarce on Lake Powell in the winter of 1995–96. The largest flock seen was of 141 on 17 January 1997 on Warm Creek Bay.

Greater Scaup (*Aythya marila*). Very rare migrant; two records. A single bird was seen flying over Bullfrog Bay on 20 January 1995, and a flock of five was seen flying over Wahweap Bay on 14 March 1996. The Greater Scaup is a rare but regular overwintering species on the Colorado River below Glen Canyon Dam, with most records between December and February (LaRue et al. 2001).

Lesser Scaup (*Aythya affinis*). A relatively common fall migrant and winter resident, with small flocks most often seen on Wahweap Bay and around Antelope Island. Lesser Scaup start appearing in October and most are gone by March. The largest flock was of 89 individuals on Wahweap Bay on 21 March 1997. This is one of the more common overwintering species on the Colorado River below Glen Canyon Dam (LaRue et al. 2001).

Surf Scoter (*Melanitta perspicillata*). Rare migrant; two records. A female-plumaged bird was seen on Wahweap Bay on 20 October 1994 (Figure 4), while another female-plumaged bird was seen on Hall's Creek Bay on 19 April 1995. This species has also been recorded several times from the Colorado River below Glen Canyon Dam (LaRue et al. 2001).

Long-tailed Duck (*Clangula hyemalis*). Rare winter resident and migrant; three or four records. A male was seen on Hall's Creek Bay on 19 January 1996, then again on 14 February 1996. A bird of unknown sex on Hall's Creek Bay on 13 March 1996 may have been the same individual. A bird of unknown sex was seen on Warm Creek Bay on 22 November 1996.



Figure 4. Female Surf Scoter on Wahweap Bay, 20 October 1994. The bird appeared to be exhausted and flew only when we approached very close in the survey boat.

Photo by J. D. Grahame/National Park Service

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

Bufflehead (*Bucephala albeola*). A common winter resident first appearing in October, with peak numbers between December and February. The species is mostly gone by March. Buffleheads frequent the upper ends of shallow bays, especially Bullfrog and Hall's Creek bays. The largest counts were of 54 on 20 December 1995 and 52 on 19 January 1996, both on Bullfrog Bay.

Common Goldeneye (*Bucephala clangula*). A common winter resident, with small flocks occurring in most survey areas, appearing in November, but most common between December and February. A few individuals linger into March. The largest single count was of 136 on Hall's Creek Bay on 14 February 1996. Numbers were much lower in 1996–1997 than in the previous two years. The Common Goldeneye is one of the most common overwintering species on the Colorado River below Glen Canyon Dam (LaRue et al. 2001).

Barrow's Goldeneye (*Bucephala islandica*). Rare winter resident; two sightings. A flock of eight was on Hall's Creek Bay on 19 February 1996, and two birds were on Wahweap Bay on 21 December 1995. On the Colorado River below Glen Canyon Dam, however, small flocks overwinter regularly (LaRue et al. 2001).

Hooded Merganser (*Lophodytes cucullatus*). Uncommon to rare migrant. Very small numbers move through the region in late fall and early winter (November–January), with a single spring record of a male on Hall's Creek Bay on 14 March 1995. The largest flock was of 13 birds on Warm Creek Bay on 29 November 1994.

Common Merganser (*Mergus merganser*). Common migrant and winter resident, with records from most survey months. Numbers peak in December and January. This species was much more common in 1995–96 than in the other years of the study. The largest flock was of 48 birds on Warm Creek Bay on 15 January 1996. The species is a common resident breeder on the Colorado River below Glen Canyon Dam (LaRue et al. 2001) and occasionally breeds on Lake Powell.

Red-breasted Merganser (*Mergus serrator*). Regular migrant in small numbers, with highest counts in early winter and spring. In the winter of 1996–97 several birds overwintered, e.g., 18 in January and 12 in February. The largest count was of 26 on Hall's Creek Bay on 13 March 1996.

Ruddy Duck (*Oxyura jamaicensis*). Uncommon fall and spring migrant, most common in October. A few birds lingered over the winter of 1996–97. The largest count was of 80 birds off Antelope Island on 27 October 1995.

American Coot (*Fulica americana*). Abundant species over the three years of the study, particularly between November and January. American Coots accounted for over 48% of all bird sightings. They were abundant in 1994–95 and common again in 1996–97. In 1995–96, however, numbers were very low except in December of 1995. The single largest count was of 3906 on Warm Creek Bay on 23 January 1997. Coots forage in a variety of ways, but on Lake Powell they generally dive in very shallow water, foraging on algae growing on rocks or drowned vegetation, associated crustaceans, and possibly small fish. Coots are strongly concentrated around the margins of shallow bays with abundant drowned tamarisk, habitat that is especially common in Bullfrog, Warm Creek, and Wahweap bays.

Killdeer (*Charadrius vociferus*). Killdeer are common migrants in the Page area but are apparently very rare on Lake Powell. Our surveys generated only two records, of a single bird at Bullfrog Bay on 29 November 1994 and three birds on Antelope Island on 18 April 1997. This species, like other smaller shorebirds, may be more common than the numbers indicate, probably easily overlooked from a boat on the water.

American Avocet (*Recurvirostra americana*). Rare; four sightings. Single birds were at Wahweap Bay on 12 April 1996 and near Antelope Island on 18 April 1997.

1994–1997 WATER BIRD SURVEYS OF LAKE POWELL

A flock of seven was at Wahweap Bay on 18 April 1997, and a group of four was at Bullfrog Bay on 17 April 1997.

Greater Yellowlegs (*Tringa melanoleuca*). Rare winter lingerer and early spring migrant with two records, of two at Bullfrog Bay on 15 February 1996 and three in the same area on 18 April 1997.

Lesser Yellowlegs (*Tringa flavipes*). Rare spring migrant; one record. Three birds were at Wahweap Bay on 18 April 1997.

Long-billed Curlew (*Numenius americanus*). Rare spring migrant, with a single record of six birds off Antelope Island on 12 April 1996.

Willet (*Catoptrophorus semipalmatus*). Rare spring migrant; three records. At Wahweap Bay two birds were with Marbled Godwits on 20 April 1995 and four birds were sighted on 18 April 1997. The largest flock of 16 birds was at Hall's Creek Bay on 17 April 1997. Otherwise this species is a sparse migrant in spring and fall at sewage-treatment ponds in the Page area (LaRue et al. 2001).

Marbled Godwit (*Limosa fedoa*). Uncommon but regular migrant in April, most likely to be seen at Wahweap Bay or around Antelope Island. The largest flight was of 168 birds on 20 April 1995 in the southern portion of the lake: 100 at Wahweap Bay, 60 on Antelope Island, and 8 at Warm Creek Bay.

Franklin's Gull (*Larus pipixcan*). Small numbers of Franklin's Gulls migrate through the Lake Powell area in April and May. Most sightings were from southern survey areas or Bullfrog Bay. April 1997 was a particularly good month, with 59 birds counted in four survey areas. The largest flocks were of 14 over Bullfrog Bay on 17 April 1997 and 43 over Wahweap Bay on 18 April 1997. On 2 May 1997, 65 birds were counted at the Wahweap sewage-treatment plant, about 1 mile from Lake Powell (LaRue et al. 2001). The numbers reported in the spring of 1997 are unprecedented for the U.S. Southwest, as most Franklin's Gulls migrate east of the Rocky Mountains (Burger and Gochfeld 1994). Regionally, most sightings are of single individuals or very small groups (Rosenberg et al. 1991).

Bonaparte's Gull (*Larus philadelphia*). Rare migrant. One record of two birds over Wahweap Bay on 27 October 1995.

Mew Gull (*Larus canus*). Rare migrant. One record of a second-year bird at Wahweap Marina from 30 November to 21 December 1996. It was the first Mew Gull recorded for Lake Powell and Glen Canyon National Recreation Area.

Ring-billed Gull (*Larus delawarensis*). Common winter resident. Ring-billed Gulls start appearing at Lake Powell in late September; they depart by late April or early May. The largest count was of 359 on 13 and 14 March 1996, with the single largest survey count of 205 on 14 March 1996 over Wahweap Bay.

California Gull (*Larus californicus*). Common migrant in spring (March–April), especially in the southern portions of the lake, but rare on fall and winter surveys. There are records for every month over the three years of surveys except January. The largest count was of 205 birds over Wahweap Bay on 12 April 1996.

Herring Gull (*Larus argentatus*). Rare migrant. Four records of single first-winter birds, at Hall's Creek Bay on 19 October 1994 and 13 March 1996, Warm Creek Bay on 5 December 1996, and Wahweap Bay on 23 January 1997.

Forster's Tern (*Sterna forsteri*). Although this species is a common fall and spring migrant through the region in May and late August or early September, sometimes in large flocks (e.g., 150 on a small island off northeast point of Antelope Island on 11 May 1995), it was recorded only once during the surveys. Four were over Bullfrog Bay on 18 April 1997.

1994-1997 WATER BIRD SURVEYS OF LAKE POWELL

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