# DEVELOPMENT OF FISH POPULATIONS AND MANAGEMENT STRATEGIES FOR THE BLENHEIM-GILBOA PUMPED STORAGE RESERVOIRS

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## ABSTRACT

Fish populations in the Blenheim-Gilboa (B-G) pumped storage reservoirs in the Catskills in New York have been studied since the reservoirs were completed in 1973. The reservoir populations developed entirely from the fishes present in Schoharie Creek and from emigrants from Schoharie Reservoir located 2.5 miles upstream. The fish populations of Schoharie Creek were composed primarily of pumpkinseed, rock bass, white sucker, and brown bullhead. Thirty-four species of fish have been collected in the reservoirs. The more common species in the upper reservoir included yellow perch, pumpkinseed and redbreast sunfish. In the lower reservoir, white sucker, carp, brown bullhead and pumpkinseed were common. Differences between the populations in the two reservoirs are attributed to differences in substrate and to loss of shallow water caused by water level fluctuations. Management techniques employed to date include removal of rough fish to enhance gamefish, construction of constant level ponds for sunfish spawning, and stocking of trout for trout fishing. A fourth technique which appears attractive is the stocking of young walleye fry to enhance the walleye fishery.

## INTRODUCTION

Pumped storage projects increase the reliability of electrical generation systems by rapidly providing energy during times of peak demand. Water is released from an upper reservoir and runs through turbines into a lower reservoir to generate electricity when peak power is needed. During periods of low power demand, water from the lower reservoir is pumped to and stored in the upper reservoir until the next period of peak demand.

Usually, the development of a pumped storage facility requires the creation of an upper reservoir with modifications to an existing adjacent body of water to function as the lower reservoir. Therefore, the fish community that develops in the upper reservoir reflects the well-established community in the lower reservoir.

Most ecological studies of pumped storage reservoirs have examined the effects of project operation on established fish populations (Miracle and Gardner, 1980). The development of the fish community and fishery in newly constructed reservoirs has generally received less attention. Questions such as, What game species are compatible with pumped storage operation? and How can these reservoirs be managed to provide a fishery? have been largely ignored.

Both the upper and lower reservoirs of the Blenheim-Gilboa pumped storage project were constructed at the same time and are similar in size. The purpose of this paper is to describe the fish populations that developed in these two reservoirs, differences between the two reservoirs, and future management options.

## THE BLENHEIM-GILBOA PROJECT

The Project is a 1,000 MW pumped storage facility located on Schoharie Creek in the northern Catskill mountains of New York (Fig. 1). Lower B-G was formed by impounding Schoharie Creek in the fall of 1971. The Project, completed in 1973, is operated by the New York Power Authority and uses a head differential of about 1,000 feet between two newly created reservoirs.

The Project is operated on a weekly cycle with Upper B-G full on Monday morning and sufficient storage on other weekday mornings for at least 4 hours generation of rated output. No generation occurs on weekends. The usual daily schedule is generation from 8 a.m. to 9 p.m. and pumping from 11 p.m. to 7 a.m. Typically, this cycle results in two units operating during the generation cycle and four units during the pump cycle. On weekends, water is pumped to Upper B-G to achieve full storage capacity. Mean water level fluctuations occurring in the reservoirs are shown in Table 1.

Schoharie Creek is the major source of water for Lower B-G, with two additional small creeks also draining into the reservoir. Two miles upstream from Lower B-G on Schoharie Creek is Gilboa Dam which

forms Schoharie Reservoir. Gilboa Dam usually spills water from late fall through late spring. Flow in Schoharie Creek between Lower B-G and Schoharie Reservoir is extremely variable ranging from 0 to 42,900 cfs during the years of the study. In the summer, the creek often becomes a series of isolated pools.

The project operation supplies Upper B-G with water. Other than precipitation and surface runoff, the reservoir has no natural inflows.

Upper and Lower B-G are similar in size and capacity (Table 1). However, Upper B-G is generally bowl-shaped with steep banks, while Lower B-G is elongate with a more gently sloping shoreline. Approximately two thirds of the bottom of the littoral zone of Upper B-G is a manmade embankment covered with riprap, while the bottom in the Lower B-G is composed primarily of silt and clay.

Water quality sampling has been conducted throughout the 10 years of Project operation. Suspended sediment concentrations in Lower B-G are less than 10 mg/l more than 80 percent of the year and rarely exceed 30 mg/l. During the summer, concentrations are usually less than 5 mg/l. Ice covers part of the reservoir in winter and a maximum daily average summer temperature of about 23°-24°C is reached in July and August. Mixing caused by project operation ensures some open water in winter. During summer, lower water temperatures are occasionally found near the bottom at the dam, but thermal stratification is minimal. In Upper B-G, suspended sediment levels and temperatures are often slightly lower than in the lower reservoir.

## MATERIALS AND METHODS

Fish have been sampled every year in Upper and Lower B-G from 1973, the first year of Project operation, through 1982. Collection methods and periods have varied; however, the two primary means of collection have been by gill nets and electrofishing. From 1973 through 1977, seines, trap nets, and block nets were also used.

Gill nets were 250 to 300 feet in length, 6 to 8 feet in depth, and had various sized meshes of 1 to 4 inches. They were set perpendicular to shore and were fished overnight.

**Table 1.—Physical characteristics of the Blenheim-Gilboa Pumped Storage Project Reservoirs.**

| Characteristic | Lower Reservoir | Upper Reservoir |
|---|---|---|
| Watershed (square miles) | | |
| Gilboa Dam spilling | 354 | < 1 |
| Gilboa Dam not spilling | 40 | < 1 |
| Surface area (acres) | | |
| Full pool | 420 | 390 |
| Minimum pool | 220 | 260 |
| Capacity (acre feet) | | |
| Full pool | 16,300 | 18,400 |
| Minimum pool | 3,600 | 5,700 |
| Shoreline length (miles) | 9.4 | 3.5 |
| Depth (feet) | | |
| Maximum | | |
| full pool | 80 | 95 |
| Mean | | |
| Full pool | 39 | 47 |
| Minimum pool | 16 | 22 |
| Water level fluctuation (feet) | | |
| Daily | 14.2 | 10.2 |
| Weekly | 27.7 | 22.7 |

Electrofishing was conducted at night along the shorelines with a pulsed direct current electrofisher.

Trap nets were composed of a rectangular box with a funnel-shaped entrance. Each net had two wings (15 ft × 20 in) and a main leader (25 ft × 20 in) bisecting the angle of the wings which directed fish to the funnel-shaped opening of the rectangular box. Nets were set so that the box was generally in water less than 8 feet deep.

## RESULTS AND DISCUSSIONS

The sources of the fish populations that ultimately developed in the B-G Reservoirs were the 5-mile section of Schoharie Creek between Gilboa Dam and Lower B-G, two small tributaries and spillover from Schoharie Reservoir. Schoharie Creek above and below the impoundment was sampled in 1973 prior to the initiation of project operation. Fourteen species of fish were collected between Gilboa Dam and Lower B-G with pumpkinseed and rock bass the most abundant. Game fishes included walleye and smallmouth bass. Fourteen species were also found downstream of Lower B-G. Pumpkinseed, fallfish, and rock bass were most abundant.

During the 10 years of sampling conducted on the B-G Reservoir, 35 species were collected (Table 2). Intensive collections of fish by trap net, seine, and boat electrofishing from April through September 1977 indicated the dominance of pan fishes (98 percent by number, 48 percent by weight) in Upper B-G and of rough fishes (47 percent by number, 81 percent by weight) in Lower B-G. Numerically, the common fishes in Upper B-G were yellow perch (63 percent of

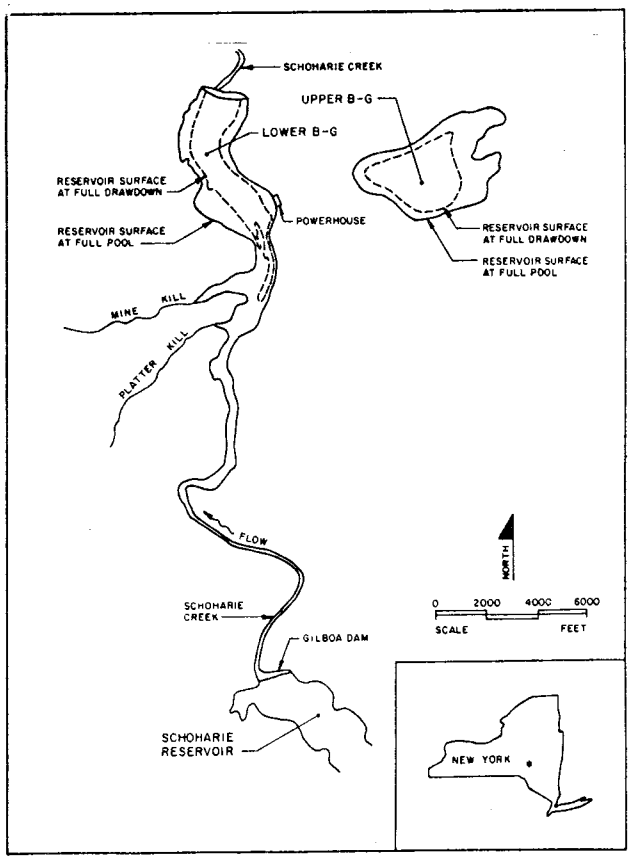


Figure 1.—Location of the Blenheim-Gilboa pumped storage project.

the total catch), pumpkinseed (22 percent) redbreast sunfish (7 percent), logperch (2 percent), and walleye (2 percent). In Lower B-G, white sucker (31 percent), carp (12 percent), brown bullhead (11 percent), pumpkinseed (10 percent), yellow perch (9 percent), and smallmouth bass (7 percent) predominated.

Early changes in certain fish populations are illustrated by trap net collections taken in the reservoirs from 1973 through 1977 (Table 3). Brown bullhead was consistently more abundant in Lower B-G than Upper B-G but its population appeared to decline in the lower reservoir from 1974 through 1977. Pumpkinseed was more abundant in Lower B-G in 1973 but its numbers decreased so that it was more abundant in Upper B-G from 1974 through 1977, through its numbers fluctuated considerably.

Redbreast sunfish and yellow perch were rarely collected by trap net in Lower B-G and no consistent trend was observed from 1973 through 1977. Redbreast sunfish was more abundant in Upper B-G but, again, its population did not exhibit any trend. Yellow perch was more abundant in Upper B-G and its population appeared to increase after 1974.

Gill net and electrofishing catches (Table 4) cannot be used to make comparisons between years because of the differences in gear, effort, and time of deployment. However, they do provide valid comparisons between fish populations in Upper and Lower B-G at several different times during the operation of the pumped storage project. White sucker was consistently more abundant in Lower B-G. Redbreast sunfish, pumpkinseed, yellow perch, and walleye were consistently more abundant in Upper B-G. Rock bass and smallmouth bass were more abundant in Lower B-G during the first half of the study but they were more abundant in Upper B-G during the second half of the study. Except for 1974 through 1975 carp was more abundant in Lower B-G.

The major factors affecting the development of the fish communities in the Blenheim-Gilboa reservoirs appear to be the morphology and substrates of the two reservoirs and their interaction with water level fluctuations. Lower B-G has a gently sloped basin, and the shoreline area subject to water level fluctuations is greater than that in Upper B-G. Two thirds of the shoreline in Upper B-G is a steeply sloped dike, thus less area is affected by fluctuating water levels. The substrate of the unexposed bottom of both reservoirs also differ. Rocky substrates predominate in Upper B-G; clay and silt in Lower B-G.

The low abundance of carp, brown bullhead, and white sucker in Upper B-G probably reflects the demersal habitats of these species and their preference for shallow water habitat. The decline of carp and brown bullhead in Lower B-G was probably caused by water level fluctuations which expose much of the shallow water spawning habitat. White sucker which spawn in Schoharie Creek were consistently more abundant in Lower B-G and did not exhibit any decline in abundance.

The greater and continued abundance of yellow perch, redbreast sunfish, and walleye in Upper B-G probably results from the fact that yellow perch is pelagic and walleye and redbreast sunfish prefer the rocky substrate which predominate in Upper B-G. Smallmouth bass and rock bass are fairly common in both reservoirs. Both species spawn in Schoharie Creek and, particularly in the case of smallmouth, spawning may also occur in the B-G reservoirs.

**Table 2.—Fishes collected in the Lower and Upper Reservoirs Blenheim-Gilboa Project from 1973 through 1982.**

| Scientific Name | Common Name |
|---|---|
| SALMONIDAE | TROUTS |
| Coregonus artedii | Cisco |
| Salmo gairdneri | Rainbow trout |
| Salmo trutta | Brown trout |
| ESOCIADE | PIKES |
| Esox niger | Chain pickerel |
| CYPRINIDAE | CARPS & MINNOWS |
| Campostoma anomalum | Central stoneroller |
| Cyprinus carpio | Common carp |
| Exoglossum maxillingua | Cutlips minnow |
| Notemigonus crysoleucas | Golden shiner |
| Notropis analostanus | Satinfin shiner |
| Notropis atherinoides | Emerald shiner |
| Notropis cornutus | Common shiner |
| Notropis hudsonius | Spottail shiner |
| Notropis rubellus | Rosyface shiner |
| Pimephales notatus | Bluntnose minnow |
| Rhinichthys cataractae | Longnose dace |
| Rhinichthys atratulus | Blacknose dace |
| Semotilus atromaculatus | Creek chub |
| Semotilus corporalis | Fallfish |
| CATOSTOMIDAE | SUCKERS |
| Catostomus commersoni | White sucker |
| Hypentelium nigricans | Northern hogsucker |
| Moxostoma macrolepidotum | Shorthead redhorse |
| ICTALURIDAE | CATFISHES |
| Ictalurus nebulosus | Brown bullhead |
| Noturus flavus | Stonecat |
| CENTRARCHIDAE | SUNFISHES |
| Ambloplites rupestris | Rock bass |
| Lepomis auritus | Redbreast sunfish |
| Lepomis cyanellus | Green sunfish |
| Lepomis gibbosus | Pumpkinseed |
| Lepomis macrochirus | Bluegill |
| Micropterus dolomeiui | Smallmouth bass |
| Micropterus salmoides | Largemouth bass |
| PERCIDAE | PERCHES |
| Etheostoma flabellare | Fantail darter |
| Etheostoma olmstedi | Tesselated darter |
| Perca flavescens | Yellow perch |
| Percina caprodes | Logperch |
| Stizostedion vitreum | Walleye |

**Table 3.—Annual catch per unit effort (number per hour) of dominant species in trap net collections taken in the Upper and Lower Blenheim-Gilboa Reservoirs from 1973 through 1977.**

| | Year | | | | |
|---|---|---|---|---|---|
| Fishes | 1973 | 1974 | 1975 | 1976 | 1977 |
| Carp | | | | | |
| Upper Reservoir | 0.02 | < 0.01 | 0 | 0 | 0.01 |
| Lower Reservoir | 0.48 | 0.01 | 0 | 0 | 0.01 |
| Brown Bullhead | | | | | |
| Upper Reservoir | 0 | 0.05 | 0 | < 0.01 | 0 |
| Lower Reservoir | 0.49 | 0.50 | 0.21 | 0.04 | 0.02 |
| Redbreast Sunfish | | | | | |
| Upper Reservoir | 0.06 | 0.09 | 0.03 | 0.05 | 0.01 |
| Lower Reservoir | 0 | < 0.01 | < 0.01 | 0 | 0 |
| Pumpkinseed | | | | | |
| Upper Reservoir | 0.09 | 0.50 | 0.28 | 0.59 | 0.14 |
| Lower Reservoir | 2.53 | 0.36 | 0.13 | 0.05 | 0.04 |
| Yellow Perch | | | | | |
| Upper Reservoir | 0.14 | 0.07 | 0.18 | 0.45 | 0.26 |
| Lower Reservoir | 0.08 | < 0.01 | 0.02 | 0.06 | 0.05 |

Pumpkinseed also spawn in Schoharie Creek but were more abundant in Upper B-G and appeared to decline in Lower B-G. This may be the result of habitat preference. The riprap in Upper B-G apparently provides more cover than found in Lower B-G.

## MANAGEMENT OF THE RESERVOIR FISHERIES

Early management of the B-G reservoirs entailed the removal of rough fish. Over 4,000 carp and white sucker each were removed from 1973 through 1979, primarily by use of block nets in Lower B-G. This removal may have contributed to the apparent decline in carp (Table 4). However, the disappearance of carp in the trap nets (which caught primarily small fish) suggests that the absence of suitable spawning habitat due to water level fluctuations was the primary cause of the decline.

Three experimental 1-acre constant level ponds were constructed along the natural shorelines of Upper B-G to evaluate their potential to supply centrarchids to the reservoir. They have been stocked since 1979 with largemouth bass and pumpkinseed and both species have spawned in these ponds. These observations suggest that on a larger scale, constant level ponds could probably make a significant contribution to reservoir fish populations and could be intensively managed to increase the production of both game and forage species.

The B-G reservoirs have also been managed for a put-and-take trout fishery. Rainbow and brown trout were stocked in the reservoirs from 1977 through 1982. Rainbow trout, in particular, have provided a put-and-take fishery and many individuals have held over to the next year.

Walleye is the dominant game fish in nearby Schoharie Reservoir and yellow perch is its primary prey. Both species are common in the B-G system, particularly in the upper reservoir. Although there appears to be some walleye spawning within the B-G reservoirs based on the presence of larvae, most recruitment is probably from Schoharie Reservoir. Schoharie Creek above Lower B-G does not provide suitable spawning habitat for walleye. The abundance of prey species (particularly yellow perch in Upper B-G) and the relative abundance of small zooplankton in the B-G reservoirs suggests that walleye abundance could be increased without unbalancing the fish community.

Mills and Schiavone (1982) maintain that the relative abundance of small zooplankton species is a useful index of the predator-prey balance in fish communities in small warmwater lakes containing predominately centrarchids and percids. These authors observed that the relative abundance of small zooplankton species increased as the ratio of predators to prey decreased.

In the B-G reservoirs, small zooplankton comprised 37 percent of the zooplankton community in Lower B-G and 42 percent in Upper B-G (Culp et al. 1978). In nearby Schoharie Reservoir, where the fish community is also dominated by a walleye-yellow perch association and good spawning habitat is abundant, small zooplankton comprise only 10 percent of the zooplankton community.

Based on the presence of catch-sized walleye in the B-G reservoirs and the means to increase their population through stocking, we conclude that there

**Table 4.—Comparison between fish abundance in the Upper and Lower Blenheim-Gilboa Reservoirs based on catch per unit effort of dominant species in gill netting and electrofishing collections from 1974 through 1982.**

| | Period[a] | | | |
|---|---|---|---|---|
| | 1974-1975 | 1976-1977 | 1979-1980 | 1981-1982 |
| Fishes | N/H | N/MIN | N/MIN | N/MIN |
| White Sucker | | | | |
| Upper Reservoir | 0.02 | 0.03 | 0.01 | < 0.01 |
| Lower Reservoir | 0.04 | 0.99 | 0.54 | 0.21 |
| Redbreast Sunfish | | | | |
| Upper Reservoir | 0.06 | 0.35 | 0.03 | 0.04 |
| Lower Reservoir | 0 | 0.01 | 0 | 0 |
| Pumpkinseed | | | | |
| Upper Reservoir | 0.18 | 0.89 | 0.13 | 0.29 |
| Lower Reservoir | 0.05 | 0.34 | 0.05 | 0.02 |
| Yellow Perch | | | | |
| Upper Reservoir | 0.19 | 4.48 | 0.23 | 1.19 |
| Lower Reservoir | 0.02 | 0.17 | 0.05 | 0.29 |
| Walleye | | | | |
| Upper Reservoir | 0.02 | 0.14 | 0.09 | 0.12 |
| Lower Reservoir | < 0.01 | 0.02 | 0.02 | 0.01 |
| Carp | | | | |
| Upper Reservoir | 0.08 | 0.05 | 0.01 | < 0.01 |
| Lower Reservoir | 0.03 | 0.21 | 0.04 | 0.02 |
| Rock Bass | | | | |
| Upper Reservoir | 0.01 | 0.06 | 0.08 | 0.59 |
| Lower Reservoir | <0.01 | 0.13 | 0.04 | 0.07 |
| Smallmouth Bass | | | | |
| Upper Reservoir | 0.01 | 0.05 | 0.09 | 0.13 |
| Lower Reservoir | < 0.01 | 0.16 | 0.07 | 0.11 |

[a]1974-1975 data based on gill net collections from April-September 1974 and 1975;
1976-1977 data based on electrofishing collections from April-October 1976 and April-September 1977;
1979-1980 data base on electrofishing collections from May, June, October and November 1979 and May and August 1980.
1980-1981 data based on electrofishing collections from October 1980 and 1981.

is good potential for the development of a percid fishery. The condition of walleye in the B-G system is good—specimens 3 years and older are about the same size and weight as comparably aged specimens from Schoharie Reservoir. The absence of good spawning habitat in the B-G system can be compensated for by periodic stocking of walleye fry. The construction of larger constant level ponds would enhance centrarchid populations and the stocking of pelagic forage species could be beneficial if predator populations greatly increased. Given the array of possible management options, it is likely that the recreational fishery in these reservoirs can be improved.

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