



PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

VOLUME 10 – NUMBER 1

WINTER 1990



★ ★ ★ ★

FLASH – Winners of the Director's Awards:

For Science, Charles Stone of Hawaii Volcanoes National Park

For Natural Resource Management, Jeri Hall of George Washington Memorial Parkway

★ ★ ★ ★

Cover: Kettle Falls Dam at Voyageurs NP (see story pages 3 and following).

Reducing the Impacts of Regulated Lake Levels On the Aquatic Ecosystem of Voyageurs NP

By Larry W. Kallemeyn

The U.S. Congress, in establishing Voyageurs NP, specified that the NPS would carry out its traditional preservation role within an established water regulatory system . . . a system that has severely disrupted the natural hydrologic cycle and has presented an environmental challenge ever since it was implemented. Thus, in 1975, the NPS became one of many interest groups concerned with the regulation of Rainy Lake and the Namakan Reservoir lakes, which are a part of the larger Lake of the Woods watershed.

Located approximately 300 miles north of Minneapolis, along the Minnesota-Ontario border, Voyageurs NP consists of 342 square miles, approximately 85,000 acres of which is covered by water. Since the early 1900s about 96 percent of the water area now included in the park has been controlled by dams that lie outside the park boundary. A dam at International Falls, Minn./Fort Frances, Ontario, which includes a hydropower facility, controls lake levels in Rainy Lake (Fig. 1). Regulatory dams at Kettle and Squirrel Falls control lake levels in Namakan Reservoir, which includes Kabetogama, Namakan, Sand Point, Crane, and Little Vermillion Lakes. The latter two lakes are outside the park. While all these lakes existed as natural water bodies, the present day reservoirs are larger and regulated to satisfy many water users.

Since the park lakes are international waters, shared with Canada, they are regulated by the International Joint Commission (IJC). Legally recognized water uses are navigation, sanitation, domestic water supply, power production, recreation, and other public purposes. Although the dams are regulated by the IJC, they have always been owned and operated by private industry. The day-to-day operation of the dams and reservoirs is usually left up to the industry, the IJC only becoming involved if its rules are not or cannot be followed.

With the IJC's existing water management programs, larger-than-natural fluctuations on Namakan Reservoir are used to maintain less than natural fluctu-

ations on Rainy Lake. Namakan Reservoir's average annual water level fluctuation is about 2.7 m* while Rainy Lake's is about 1.1 m (Fig. 2). The fluctuation of Namakan Reservoir is about 0.9 m greater than the estimated natural or pre-dam fluctuation while Rainy Lake's is about 0.8 m less (Flug 1986). Namakan Reservoir's overwinter (October to April) drawdown is approximately 2.0 m greater than the estimated natural fluctuation for this time period while Rainy Lake's is about the same as it would be under natural conditions. The timing of the fluctuations also is different under the regulated system. Regulated lake levels on Namakan Reservoir usually peak in late June or early July rather than late May or early June as they did prior to dam construction. They then remain stable on both Rainy Lake and Namakan Reservoir throughout the summer instead of slowly declining.

Concerns about the effects of regulated lake levels on the aquatic biota, particularly the fish community, have existed ever since the dams were constructed. However, establishment of the park, with its emphasis on restoring and preserving the natural environment and archeological resources, heightened those concerns, particularly in regard to effects of the regulated lake levels on the aquatic ecosystem (Cole 1979, 1982).

Research Program

A research program was initiated by NPS to assess impacts of the regulated lake levels on the park's aquatic ecosystem and to develop alternatives to the present water management program (Kallemeyn 1983). The first component of the program consisted of studies of the effects of present water management on species and communities thought to be sensitive to changes in water levels. The studies were carried out by researchers from several universities and the NPS (Table 1). Additional studies conducted to obtain baseline information pertinent to the regulated lake level issue dealt with primary production in Voyageurs' four large lakes and the relationship between lake levels

*1m = 39.37 in.

and boat docks. Results of studies conducted by other researchers, while not specifically a part of this program, were used to assess the impact of the regulated lake levels on the park's archeological resources.

Next, researchers developed a hydrological model to assess effects of alternative regulatory programs (Flug 1986). The model simulated the multi-lake system beginning with inflows of Namakan Reservoir and ending with outflows from Lake of the Woods. In order to restrict the modeling effects to this portion of the basin, outflows from Lake of the Woods were given the highest priority and were forced to match actual historic releases.

This approach was used because it would allow the NPS to present meaningful recommendations to the IJC for alternative regulatory programs if the research results showed that the current water management program was having adverse impacts on the aquatic biota. It would also allow testing whether alternative programs that more closely approximate natural conditions could be used to reduce adverse effects on the aquatic biota without seriously conflicting with the other authorized water uses (Cole 1982). Should the IJC authorize an alternative program, this information would serve as baseline information which could be used to evaluate the impacts of the new regulatory system on authorized water uses.

Environmental Consequences

The species and biological communities investigated in Voyageurs generally were found to be adversely affected by the present water management programs. They were especially impacted by the greater than natural water level fluctuations on the Namakan Reservoir lakes. These plants and animals have been unable to adjust to the changes in the magnitude and timing of lake level fluctuations since the dams were constructed, and in particular to the water management program used since 1971.

Negative impacts on Voyageurs' aquatic ecosystem occurred throughout the year. Those that took place in

Continued on page 4

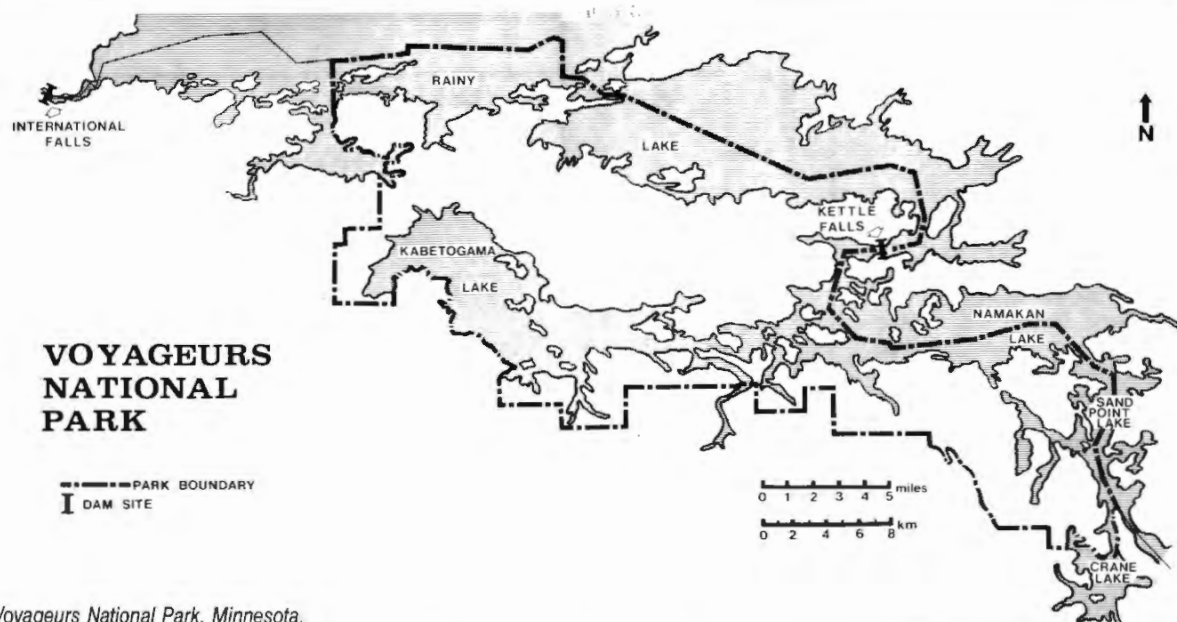


Figure 1. Voyageurs National Park, Minnesota.

Voyageurs NP Lake Levels

(Continued from page 3)

a particular season frequently were the result of a combination of water level conditions that occurred in previous seasons. For example, high stable summer and early fall water levels contribute to spring spawning problems for northern pike and walleye by causing potential vegetative and wave washed gravel spawning substrates to develop at relatively high elevations. This, in combination with a large winter drawdown, makes the flooding of these preferred substrates the following spring difficult, particularly in low runoff years. Thus, while poor spawning conditions are usually blamed on low spring water levels, they are actually the culmination of a series of water management actions that occurred throughout the year.

Similar interactions were observed for the other organisms studied. The large winter drawdown on Namakan Reservoir and the resultant low spring water levels make large water level changes necessary in May and June to meet navigational needs. These changes were found to adversely affect aquatic bird nesting success and establishment of wild rice stands. During the period from 1983 to 1985, 47 percent of the loon nests on Namakan Reservoir were lost to flooding while on Rainy Lake, with its less than natural fluctuations, 27 percent were lost. Red-necked grebes were even more sensitive to lake level changes. From 1983 to 1985, 77 percent of the grebe nests on Namakan Reservoir were lost to flooding; on Rainy Lake 45 percent were lost.

High stable summer water levels, extremely favorable for navigation, appeared to limit the establishment of wild rice and other aquatic vegetation. They also caused beaver and muskrat to build their lodges and food caches at elevations that left them extremely susceptible to the larger than natural winter drawdown Namakan Reservoir experiences annually. The winter drawdown, which causes up to 25 percent of the Namakan Reservoir area to be dewatered annually, forced nearly 80 percent of the beaver to abandon their lodges and food caches. These beaver spent most of the winter in wood-chip nests under the ice outside their lodge and were forced to find other food. As a result, they lost more weight, had fewer offspring, and were more susceptible to predation than beaver from more stable, inland ponds.

The large winter drawdown also forced otter to alter their home ranges and limited the diversity and abundance of benthic organisms, an important food source for fish. Similar effects were noted for aquatic vegetation.

The present water management program was found to adversely impact the park's archeological resources. Approximately 75 percent of the archeological sites were partially or totally destroyed by the rise in lake levels resulting from the building of the dams. Of the sites that remain, only those located behind and protected by bedrock shorelines have escaped damage. The remaining sites, even though they are located above the present maximum lake levels, continue to be impacted by the undercutting and bank slumping that results from intense wave action during the period when lake levels are at their summer peaks. An archeological site stabilization program was initiated in 1985 but to date only three sites have been completed.

It is felt that most of these biological and archeological problems could be overcome by implementation of a water management program that more closely approximates the magnitude and timing of natural fluctuations in lake levels with which the affected species

Table 1. Names and affiliations of researchers involved with regulated lake level studies in Voyageurs National Park, 1983-1987. (P.I.) = Principal Investigator.

Hydrology

Dr. Marshall Flug

NPS, Water Resources Division

Primary Production

Dr. Robert Stottlemeyer (P.I.)

NPS, Great Lakes Area Resource Studies Unit
Michigan Technological University

Ray Kepner

Fisheries

Larry Kallemeyn

NPS, Voyageurs National Park

Beaver-Muskrat-Otter

Dr. Rolf Peterson (P.I.)

Michigan Technological University

Douglas Smith (beaver)

Michigan Technological University

Joanne Thurber (muskrat)

Michigan Technological University

William Route (otter)

Michigan Technological University

Shore and Marsh Nesting Birds

Hildegard Reiser

Northern Arizona University

Osprey

Dr. Francesca Cuthbert (P.I.)

University of Minnesota, St. Paul

Arlene Rothstein

University of Minnesota, Duluth

Aquatic Vegetation

Dr. Paul Monson

University of Minnesota, Duluth

Dr. Douglas Wilcox

NPS, Indiana Dunes National Lakeshore

James Meeker

University of Wisconsin

Benthos

Dr. Kenneth Kraft

Michigan Technological University

Boat Docks

Larry Kallemeyn

NPS, Voyageurs National Park

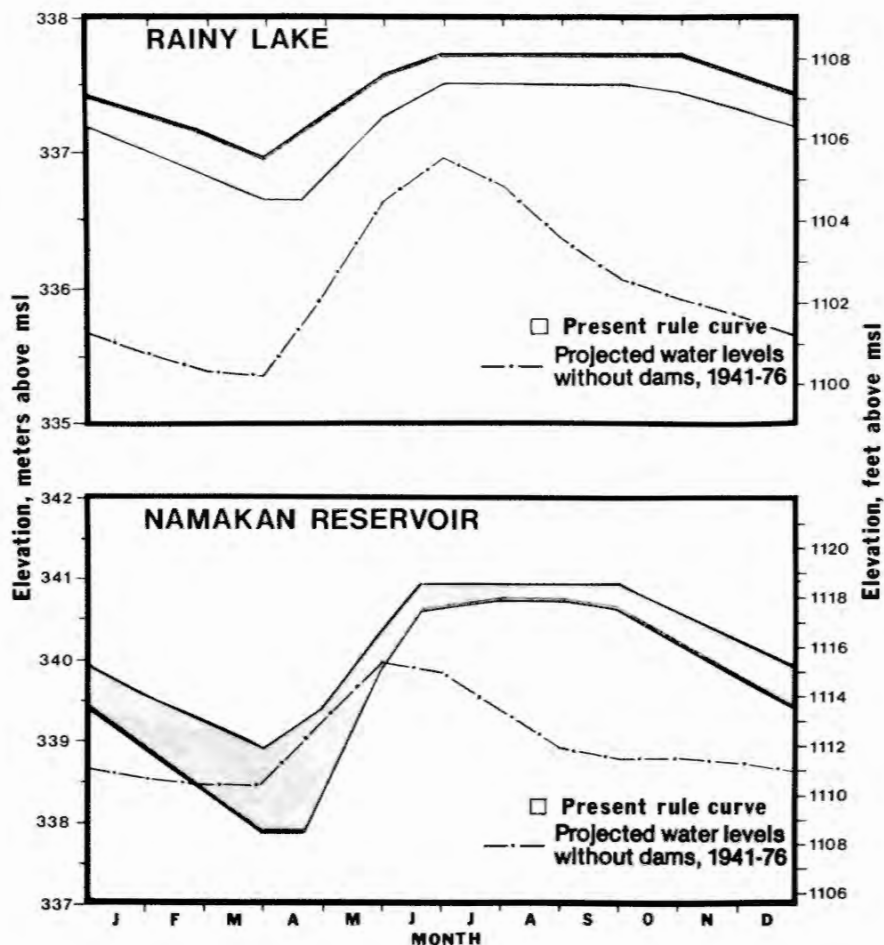


Figure 2. Present water management programs (Rule Curves) and computed natural lake levels for Rainy Lake and Namakan Reservoir, Minnesota and Ontario, Canada. Elevations given in meters and feet above mean sea level (msl).

Voyageurs NP Lake Levels

(Continued from page 4)

evolved. Obviously, complete restoration of natural conditions in the park is not possible due to the presence of the dams and the requirements of other water users. However, development of an alternative water regulatory program that is more ecologically sound appears possible given our understanding of the relationship between water levels and various biological factors.

Alternative Regulatory Programs Assessment

Using the research study results as well as input from other water users, 15 alternative regulatory programs were developed. Each alternative was analyzed with the hydrology model to see if the reservoir system could accommodate the modified program under normal hydrologic conditions as well as extreme high and low water conditions. The model also provided projections of hydropower production for each alternative.

To tie the results of the environmental studies and the hydrology model to potential impacts from the various alternative regulatory programs, an impact assessment matrix was developed. The study results and information from the scientific literature were used to develop ranking factors for 22 resource attributes, including in addition to the various biological factors, hydropower production, navigation, flood control, and boat dock usability and susceptibility to ice damage. These ranking factors were then used to evaluate the effect of each alternative regulatory program on the various attributes, with the results entered into the matrix. The matrix, although based on simplifying assumptions about complex ecological and economic relationships, provided a means of integrating the information so that it could be used to facilitate discussions among the various water users.

The matrix is now being used by NPS and a coalition of citizen groups, resort and other commercial interests, and fishermen to develop a consensus for an alternative that they can recommend to the IJC - one that will meet all their needs and still restore more natural hydrological conditions to this reservoir system.

An example of this selection process is this comparison of the alternative regulatory programs, L8 and BLC-88 (Fig. 3). If the only consideration were restoration and conservation of Voyageurs' natural environment, alternative L8 would be preferred, since it approximates natural hydrologic conditions and consequently receives high rankings for most of the biological attributes. Because of its summer drawdown, however, it would receive low rankings in regard to navigation and dock usability in late August and September. BLC-88 with its reduced summer drawdown is an attempt to improve conditions for those attributes while still providing favorable conditions for the various biological attributes. Other conditions under the two alternatives would be similar.

Obviously, compromises such as this will be necessary to meet the legally recognized needs of the other water users and will preclude the complete restoration of natural conditions in the park. Implementation of any alternative will need to be accompanied by research and monitoring programs designed to document the actual effects of the modifications on the different interests. This will allow testing whether an alternative program can reduce the adverse effects on Voyageurs' aquatic ecosystem without seriously conflicting with other water uses. Based on such research and monitoring results, the alternative program could, if necessary, be further adjusted to achieve desired results for all.

Kallemeyer is Aquatic Research Biologist at Voyageurs NP.

Literature Cited

- Cole, G.F. 1979. Mission-oriented research in Voyageurs National Park. *Proceedings Second Conference on Scientific Research in the National Parks* 7:194-204.
- Cole, G.F. 1982. Restoring natural conditions in a boreal forest park. *Transactions of the 47th North American Wildlife and Natural Resources Conference*, pp. 411-420.
- Flug, M. 1986. Regulated lake levels and Voyageurs National Park. *Park Science* 7:21-23.
- Kallemeyn, L.W. 1983. Action plan for aquatic research at Voyageurs NP. *Park Science* 4:18.

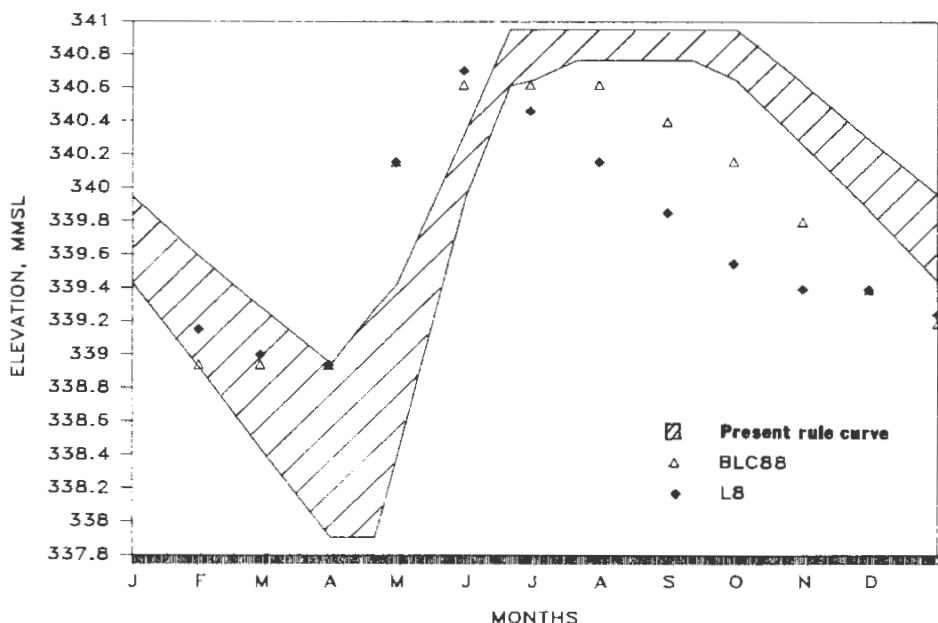


Figure 3. Comparison of the present water management program (Rule Curve) and alternative regulatory programs, L8 and BLC88.