An Attempt to Rehabilitate the Aquatic Ecosystem of the Reservoirs of Voyageurs National Park

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VOYAGEURS NATIONAL PARK
International Falls, Minnesota

Voyageurs National Park, which was authorized in 1971 and established in 1975, is located approximately 300 miles north of Minneapolis, Minnesota, along the Minnesota-Ontario border. The park encompasses 88,628 hectares, of which approximately 34,400 hectares, or 39%, is covered by water. Kabetogama Lake and those portions of Namakan, Sand Point, and Rainy lakes that lie within the park make up 96% of the water area.

Lake levels in the park's large lakes have been controlled by a hydroelectric dam at the outlet of Rainy Lake and by regulatory dams on Namakan Lake's two outlets since the early 1900s. The latter dams control the lake levels in Namakan Reservoir, which includes Kabetogama, Namakan, Sand Point, Crane, and Little Vermillion lakes. The latter two lakes are, as are the dams themselves, outside the park boundary. While all these lakes existed as natural water bodies, the present day reservoirs are larger and regulated to satisfy a variety of water users.

Since these are international waters, shared by Canada and the United States, they are regulated by the International Joint Commission (IJC). Legally recognized water uses are navigation, sanitation, domestic water supply, power production, and recreation and other public purposes. While the dams are regulated by the IJC, they have always been owned and operated by private industry. Day-to-day operation of the dams and reservoirs is usually left up to the industry as long as they maintain water levels within the IJC's "rule curves," which are bands of permitted high- and low-water levels throughout the year.

The "rule curves" use larger-than-natural fluctuations in lake levels on Namakan Reservoir to maintain less-than-natural fluctuations 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. The fluctuation of Namakan Reservoir is about 0.9 m greater than the estimated natural (pre-dam) fluctuation while Rainy Lake's is about 0.8 m less (Flug 1986). The timing of the fluctuations is also different under the regulated system. Regulated lake levels usually peak in late June or early July rather than late May or early June as they did before the dams were built, remain stable throughout the summer rather than gradually declining, and on Namakan Reservoir decline 1.8 m over winter rather than 0.6 m.

Concerns about the effects of the regulated lake levels on the aquatic biota and in particular those organisms and plants that occur in the littoral zone have been expressed ever since the dams were constructed. However, the establishment of Voyageurs National Park, with its emphasis on restoring and preserving the natural environment, resulted in a heightened concern about the impacts of the regulated lake levels on the aquatic ecosystem (Cole 1979, 1982).

Research Program

Because of those concerns, in 1983 the USNPS started a research program to assess the impacts of the regulated lake levels on the park's aquatic ecosystem and develop possible alternatives to the present water management program. The primary elements in this program were:

- ✦ The development of a hydrological model that could be used to assess the effects of alternative regulatory programs; and
- ✦ An analysis of the impacts of the present operating system on littoral vegetation; benthic organisms; the fish community, particularly walleye, *Stizostedion vitreum*, and northern pike, *Esox lucius;* shore and marsh nesting birds, particularly the common loon, *Gavia immer,* and red-necked grebe, *Podiceps grisegena;* and aquatic furbearers, including beaver, *Castor canadensis*, muskrat, *Ondatra zibethicus*, and river otter, *Lutra canadensis*.

Additional studies to obtain baseline information dealt with primary production in the park's large lakes and the relationship between lake levels and boat docks. Archeological surveys from within the park, while not specifically a part of this program, provided information that could be used to assess the impacts of the reservoirs on those resources.

This approach was used because it would allow the USNPS to present recommendations to the IJC for alternative regulatory programs if warranted. It would also allow testing whether alternative programs that more closely approximated natural conditions could be used without seriously conflicting with the other water uses (Cole 1982). Should the IJC authorize an alternative, results from these studies could serve as baseline information which could be used to evaluate the impacts of the new regulations.

Environmental Impacts

The species and biological communities that were investigated were generally found to be adversely affected by the present water management programs, and in particular the greater-than-natural fluctuations in water levels on Namakan Reservoir. The plants and animals have been unable to adjust to the changes in the magnitude and timing of fluctuations since the dams were constructed, and in particular to the current water management program.

Impacts on Voyageur's aquatic ecosystem occurred throughout the year. Those in a particular season frequently were the result of a combination of water level conditions in previous seasons. For example, summer and early fall water levels that are both high and stable, while extremely favorable for navigation, 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 and reproductive success 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 (Kallemeyn 1987a, 1987b).

Similar interactions were observed for the other organisms that were studied in the park. The stable summer and fall water levels also caused beaver and muskrat to build their houses and food caches at elevations that left them extremely susceptible to the large winter drawdown Namakan Reservoir experiences annually (Smith and Peterson 1991, Thurber et al. 1991). The winter drawdown, which causes up to 25% of the area of Namakan Reservoir to be drained, forced otter to change their home ranges (Route and Peterson 1988) and limited the diversity and abundance of benthic organisms, an important component of the aquatic food web (Kraft 1988). The winter drawdown and the resulting 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 nesting success of common loons and red-necked grebes (Reiser 1988).

Lake-level regulation also affected the aquatic macrophyte communities in Rainy and Namakan lakes (Wilcox and Meeker 1991). Both communities were dominated by different species and exhibited less structural diversity than the macrophyte community in a nearby unregulated lake, which experiences an intermediate level of hydrologic disturbance. The lower level of disturbance in Rainy Lake resulted in a stable macrophyte community with little diversity. In Namakan Lake, with its greater-than-natural fluctuation and long winter drawdown, the dominant species were those capable of surviving physical disruption or of invading and maturing quickly.

Those archeological resources that survived the initial filling of the reservoirs continue to be affected by the present water management program. While the majority (75%) of the sites were damaged or destroyed when the reservoirs were initially filled, those that remain continue to be affected by the undercutting and bank slumping that results from intense wave action during the summer high-water period (Lynott et al. 1986). Only those sites located behind and protected by bedrock shoreline have escaped damage.

DEVELOPMENT OF MANAGEMENT ALTERNATIVES

Management techniques providing a hydrologic regime more closely approximating that with which these species evolved appears to be the best means of overcoming the problems. Using such an approach in wetlands management is believed to benefit more plants and animals and to result in a more typical marsh community than more artificial management techniques (Weller 1978, Ball 1985). Such an approach is also in keeping with the USNPS's mandate to protect, perpetuate, and restore natural environments and native species in national parks, such as Voyageurs (Hayden 1976). The degree to which natural conditions can be restored in these reservoirs will of course be limited by the necessity of meeting the needs of the other water users. But even with those limitations, it should still be feasible to develop more ecologically sound water regulations given our understanding of the relationships between hydrologic conditions and the various biological factors.

The study results and comment from other water users were used to develop alternative regulatory programs. Each consists of a pair of rule curves, one for Rainy Lake and one for Namakan Reservoir. Each alternative was first analyzed with the hydrology model to see if the reservoir system could accommodate the alternative under normal hydrologic conditions as well as extremes. The model also provided projections of hydropower production for each alternative.

To tie these results to potential impacts from the various alternatives, an impact assessment matrix was developed. Results and information from the scientific literature were used to develop ranking factors for those resources addressed in the studies as well as others considered significant to the area that would be affected by changes in the rule curves. These included, in addition to the various biological factors, hydropower production, navigation, flood control, archeological resources, public beaches, and boat dock useability and susceptibility to ice damage. These ranking factors were then used to evaluate the effect of each alternative 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 various water users.

This evaluation procedure is now being used by a steering committee consisting of U.S. and Canadian representatives from private industry, the public, and government, including the USNPS, to develop a consensus on how the waters of Rainy Lake and Namakan Reservoir should be managed. This committee arose partly as a result of a U.S. Federal Energy Regulatory Commission (FERC) licensing action for the U.S. portion of the hydroelectric dam at the outlet of Rainy Lake. The license, which was issued in December 1987, required the licensee to "develop a water-level management plan for Rainy Lake to ensure the protection and enhancement of water quality, fish and wildlife, and recreational resources in Rainy Lake." The pertinent U.S. agencies (the USNPS, U.S. Fish and Wildlife Service, and Minnesota Department of Natural Resources), recognizing the international implications of such a plan and the need to address concerns related to Namakan Reservoir, worked with their Canadian counterparts to establish the steering committee so that the concerns of both U.S. and Canadian water users could be addressed. Should a plan be selected that calls for changes requiring the approval of the IJC, the licensee is required to submit it to them before filing it with FERC.

Meeting the needs of all the legally recognized users will not be easy. Compromises will need to be made, particularly in regard to integrating some of the annual and long-term variation that is an integral component of an unregulated hydrologic system. While inclusion of that variability in a management plan would be looked upon favorably from a natural resource perspective, users that require a consistent source of water would most likely find it unacceptable. To meet their needs while incorporating some of the natural variability will require the development of a forecasting system that lets them plan ahead to adjust to changes in runoff and lake levels.

FUTURE NEEDS

Continuing monitoring and research must be an integral component of any alternative water management plan. Only with such information will it be feasible to determine if the program is working. Should that not be the case, the study results could serve as the basis for further changes. To be successful, this assessment process must also provide for the continued involvement of those affected. Monitoring and research results must be given out to these parties so they can continue to make informed decisions regarding the impacts of reservoir operations. This sharing of information and continuing dialogue, while not necessarily ensuring the resolution of differences between parties (Huser 1985), does in this instance appear to be a logical means of providing for an objective evaluation of alternatives. It is to be hoped that this process will result in water management which is capable of both protecting the aquatic resource and associated biological communities and meeting the needs of the human users.

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