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Managing the Water Resources of the Oswego River Basin in Central New York

FL-LOWPA
Finger Lakes - Lake Ontario Watershed Protection Alliance

INTRODUCTION

The Oswego River Basin in central New York State contains a diverse system of streams, lakes, and canals. Water flows from upland streams to the Finger Lakes, then to low-gradient rivers, which are part of the New York State Barge Canal, and ultimately to Lake Ontario (fig. 1). Although natural and man-made components of this hydrologic system are known, how the system functions and how the components interact are not completely understood. This Fact Sheet is a result of a shared interest on the part of U.S. Geological Survey (USGS) and Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA) in facilitating public understanding and discussion of the complex Oswego River Basin and its water-resource-management issues.

PHYSIOGRAPHY OF THE OSWEGO RIVER BASIN

The Oswego River Basin has an area of 5,100 square miles and encompasses three physiographic provinces — the Appalachian Plateau, the Tug Hill Plateau, and the Lake Ontario Plain (fig. 2). One additional geographic area that plays a vital role in the flow regime of the Basin is the Clyde/Seneca River-Oneida Lake Trough, a belt of lowlands running west-to-east through which the Barge Canal flows. The trough is key to understanding the Oswego River Basin flow system — its natural and human-altered "plumbing".

Base from U.S. Geological Survey digital data, 1:2,000,000, 1972. Standard parallels 29 30' and 45 30', central meridian -96 00'.
Albers Equal-Area Conic projection

Figure 1. Location of major lakes and rivers, New York State Barge Canal, and major cities within the Oswego River Basin in Central New York

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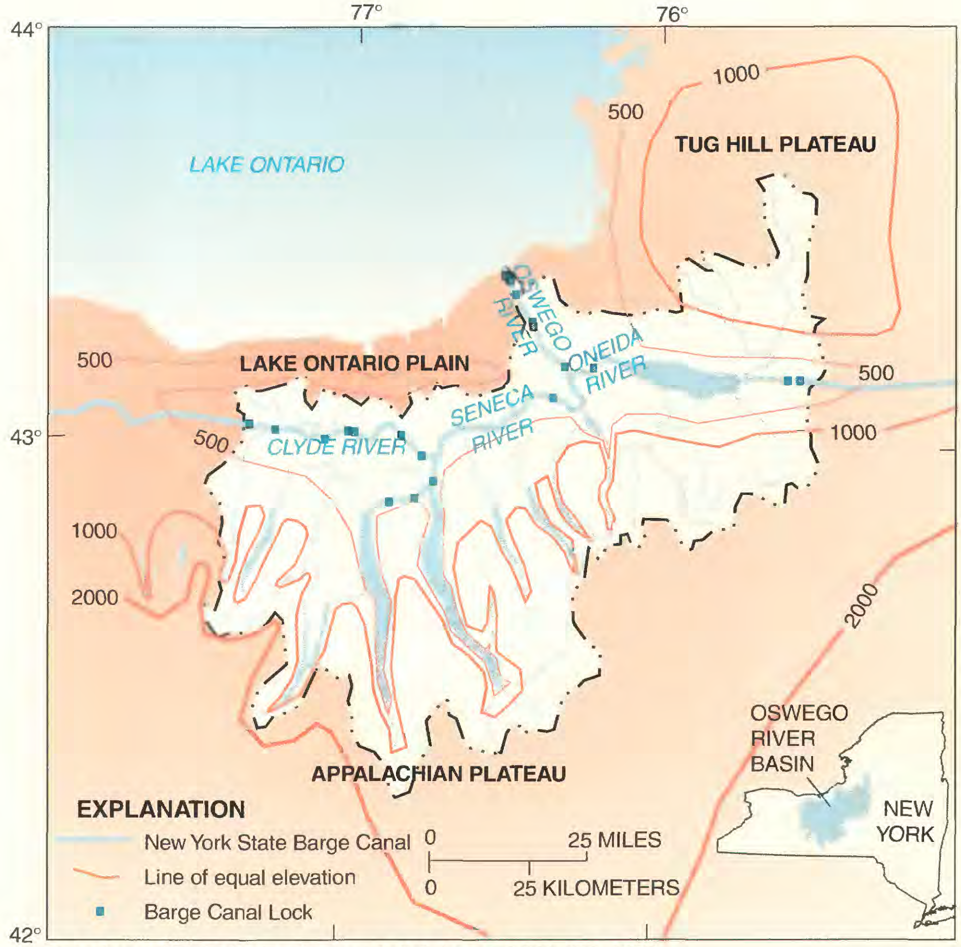
Clyde/Seneca River-Oneida Lake Trough

The trough is a product of regional geology and glaciation. During and after the last Ice Age (ending about 14,000 years ago), glaciers carved-out erodible shales that lie between the Lockport Dolomite bedrock "ridge" to the north of the trough and Onondaga Limestone bedrock "ridge" that forms the northern edge of the Appalachian Plateau to the south. The trough was subsequently filled with mixtures of clay, silt, sand, and gravel from the receding glacier. The result was a flat, low-lying area with many square miles of wetlands, some of which are now farmed as muckland. The New York State Barge Canal was constructed within the trough because the gradient is exceptionally low. The Canal's surface elevation drops only 23 feet in 60 miles along the main stem between Locks 27 and 24. Before construction of the canal in the early 1800's, the gradient averaged about 0.4 feet per mile; with the canal, the water-surface elevation changes in steps at each of the locks. The low gradient poses a challenge to water-resources management because the natural and man-made gradient inhibits the rapid movement of large volumes of water.



Base from U.S. Geological Survey digital data, 1:2,000,000, 1972.
Standard parallels 29 30' and 45 30', central meridian -96 00'.

Figure 2. Physiographic provinces of the Oswego River Basin and generalized land-surface elevation

Effect of the Trough on Basin Drainage

Surface water and ground water in the Oswego River Basin flows from upland watersheds to rivers and lakes and then to the trough containing the main stem of the New York State Barge Canal. As illustrated in figure 3, water flows from the outlet of Keuka Lake to Seneca Lake, with a change in elevation of about 270 feet, and from Seneca Lake to Cayuga Lake with an elevation change of about 60 feet, then from Cayuga Lake to the Barge Canal through the Mudlock gate-structure where the fall is only 9 feet. During some major storm-runoff periods, the water-surface elevation in the Barge Canal near Montezuma (just downstream from the Cayuga Lake outlet) has exceeded the water-surface elevation in Cayuga Lake; and if the Mudlock gates had been open, water would have flowed from the Barge Canal into Cayuga Lake.

The area near Montezuma receives about 48 percent of the runoff from the Oswego River Basin's 5,100 square miles. Further downstream (to the east), the canal receives additional water from the Owasco, Skaneateles, and Otisco Lake watersheds, which, like Canandaigua Lake to the west, are at higher elevations and drain readily to the trough. Similarly, the uplands around Oneida Lake drain to the eastern end of the trough from the surrounding watershed, and the additive contribution of these lake outflows to the Barge Canal results in a "bottleneck" at Three Rivers junction (the confluence of the Seneca, Oneida, and Oswego Rivers). This junction receives water from 96 percent of the Oswego River Basin but is within the flattest, slowest-moving reach of the Barge Canal and the Oswego River Basin. At times, inflow to the trough exceeds the channel capacity and causes flooding within Seneca, Cayuga, and Oneida Lakes and along the Seneca and Oneida Rivers. The gradient in the Oswego River, downstream of Fulton, increases markedly to 118 feet in 29 miles (4 feet per mile), and allows the water to flow more readily toward Lake Ontario.

NOT A FLOODPLAIN PROBLEM, BUT A WATERSHED CONSIDERATION

The amount of water that enters any Finger Lake from a storm depends on local watershed conditions. For example, when soils are saturated or frozen in the Cayuga Lake watershed, for every inch of water that falls on the watershed and runs off to the lake, the lake level increases by one foot within 1 to 2 days, but once in the lake, this amount of water can take a week or more to fully drain to the Barge Canal because the lake level can be lowered by only a tenth of a foot per day due to the low gradient of the Seneca River/Barge Canal and the difference in elevation between the River and Cayuga Lake. The natural drainage within this basin, with its cumulative, rapidly flowing upland discharges and a slowly draining outflow, poses difficulties for water-level management. The New York State Barge Canal Corporation uses "control points" within the Oswego Basin to monitor and manage water levels. The management strategies of this system have been controversial for nearly a century because the users desire differing water-level-management results. Reaching resolution is not simple, nor is any decision favorable to all.

Most water-resource problems within the Oswego River Basin (or any other basin) tend to be looked upon as local water-level issues, property issues, water-quality issues or single-use issues. The first responsibility and challenge to water-resource managers and users is to view all issues within the context of basin-wide management. Only when the focus is on the entire system will the basin residents be able to define reasonable goals and work toward them.

Thus, water level, water-quantity, or water-quality problems within the Basin need to be considered on a watershed basis, rather than as isolated problems along a particular stretch of river or lake. As an example, an upland farmer might install drain tile to remove water from his fields so that he can work the fields earlier in the season. This common practice can cause more water to flow into a nearby roadside ditch, and prompt the town highway department to deepen the ditch. The increased flow from the ditch now could increase erosion and possibly cause a downstream culvert to clog and cause localized flooding. The town replaces the culvert with a larger one, allowing more water to move through more quickly. This in turn could erode denuded road banks, and carry enlarged sediment loads to a river or lake where the sediment is deposited as an alluvial fan that clogs the mouth of the stream and may cause flooding of nearby property. The town then excavates this sediment and removes more than was deposited to avoid the need to reexcavate in the near future. This over excavation can begin a process of stream erosion that may spread upstream into the watershed, causing further erosion of streambed and the streambanks. In this hypothetical example, each individual action benefits the local situation, but the cumulative effect alters stream conditions in the watershed, and can cause a natural process of erosion and(or) deposition, which may be viewed in a detrimental way from some perspectives. Whenever a stream is disturbed locally, it needs time to restore its gradient and streambank conditions, and if the disturbance (natural or man-made) is large enough, the watershed can be affected well beyond the initially-affected area, and can take a decade or more to reach a new equilibrium.

LIMITATIONS IN WEATHER FORECASTING AND UNDERSTANDING CLIMATE VARIABILITY

Today's forecasting "skill" or accuracy in predicting a precipitation amount is accurate to only about 2 days into the future. The accuracy of extended forecasts (beyond 2 days) diminishes sharply thereafter; only the probability of precipitation (as a percent) is given and the amount is not predicted. Seasonal (3- to 4-month) forecasts are highly generalized, and are given only in terms of wetter (or drier) or hotter (or cooler) than the long-term norm or average condition. Management of a region's water resources, especially those within a complex system such as the Oswego River Basin, is difficult with only a 2-day lead time for specific weather information.

Longer term weather and climate conditions, incorporating the concepts of global warming and climatic variability, must rely on long-term records of the earth's climate; but systematic records only extend to 100 years ago or less. One means of extending the record farther back in time is through dendrochronology (the study of tree rings). Studies in forests in the northeastern United States indicate that precipitation and air temperature variability followed a generally calm, cyclic pattern between 1890 and 1960, with relatively few departures from the norm, but have departed from this cycle in the form of droughts, floods, and periods of extremely cold or extremely warm temperatures more frequently since the 1960's. The mid-1960's were characterized by drought, whereas 1993 and 1996 were extremely wet with heavy seasonal precipitation and rapid snowmelt. The recent, more erratic weather might be an aberration, but tree-ring data for the 1700's and 1800's indicate many departures from the norms of the 1890-1960 period.

The seemingly erratic weather patterns of recent decades may, in fact, be more typical for the Oswego River Basin than the period of relative calm between 1890 and 1960. One implication of this possibility is that watershed systems will be more difficult to manage in the near future than before 1960. Our relatively short record of local rainfall and runoff conditions, therefore, is not a reliable indicator of future weather, nor of the resultant lake levels, or river-flow conditions.

WATER-QUALITY CONSIDERATIONS

Water quality in the Finger Lakes is suitable for most uses with minimal treatment, but it cannot be assumed to remain so indefinitely. The introduction of zebra mussels (a non-native species) has led to an increase in the clarity of the water, but increased clarity does not necessarily imply diminished pollution. About 20 cities, towns, and villages within the Oswego River Basin use the Finger Lakes as a drinking-water source, and nearly the same number use the lakes for disposal of treated wastewater. Nutrients and pesticides have been detected in all of the Finger Lakes, although at concentrations below current drinking-water standards. The quality of water entering and moving through the Oswego River Basin is adversely affected by other human activities as well, and the resulting contamination can diminish the suitability of these water resources for certain uses. The phrase "we all live downstream" is a reminder to all that our actions can affect others.

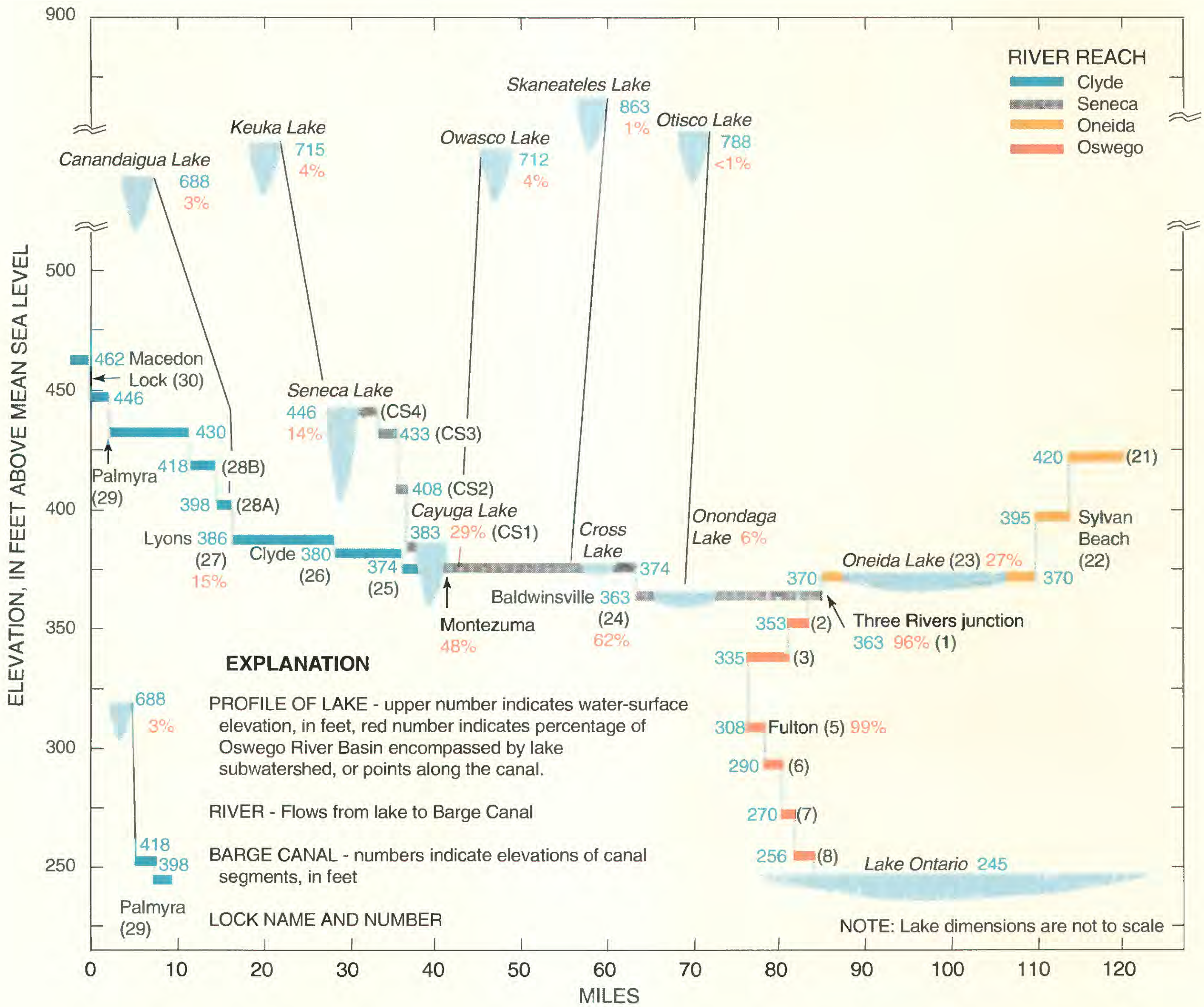


Figure 3. Relative lake and lock positions, water-surface elevations, and percentage of Oswego River Basin occcupied by selected lake and canal watersheds. (Locations shown in fig. 1).

Q & A

WHAT CAN BE DONE TO IMPROVE WATER RESOURCES?

Managing the water resources of the Oswego River Basin is a daunting task, but some steps that can be taken to improve these resources are:

1. UNDERSTAND THE CONCEPT OF WATERSHED PROCESS -

Everyone, from the upland farmer to the lakeside landowner, lives in a watershed. Thus, everyone's actions affect the quality and quantity of the water resource. The adverse effects of human activities can be minimized within the watershed, but only with resolve to meet clearly-defined watershed goals. Conditions within the natural system are in a state of perpetual change, and man has only a limited ability to alter them. Although the effects of some extreme-weather conditions may be reduced, they cannot be eliminated.

2. INVOLVE THE PUBLIC -

Educate the public in the watershed process, and involve the residents of the basin (stakeholders) in planning, management, and goal setting. Encourage individuals to plan and manage their properties as part of a larger watershed system.

3. ENSURE THAT LOCAL ACTIONS CONFORM TO BASINWIDE WATER-MANAGEMENT OBJECTIVES -

Set basinwide water-management goals before imposing local objectives or solutions. Address local problems within the context of total watershed management.

4. DEVELOP GOALS THAT ARE CONSISTENT WITH THE "REAL WORLD" -

Explore whether the proposed goals are realistic and consistent with the basin's hydrologic characteristics, climate and precipitation variability, and canal hydraulics.

5. REALIZE THE POTENTIAL AND LIMITATIONS OF WATERSHED MANAGEMENT -

Watershed hydrology and canal hydraulics can be simulated by computer models that, when calibrated and verified with sufficient data, can be used to develop and refine water-management strategies and to define our limitations in manipulating our water resources.

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FACING CHALLENGES IN THE OSWEGO RIVER BASIN

Establishing Goals and Priorities in Water-Resource Management

The Finger Lakes - Lake Ontario Watershed Protection Alliance (FL-LOWPA) sponsored a policy dialogue forum on water-level management in the Oswego River Basin on September 16, 1997. Stakeholders, including representatives from Federal, State, and County agencies, municipalities, businesses, and citizen associations, were invited to participate. The goals for the forum were intentionally modest: (1) to identify and clarify stakeholder interests in the management of water levels in the Oswego River Basin; (2) to reach agreement on a set of key issues; and (3) to reach consensus on the primary steps to address key issues.

Forty-four participants represented an even balance among various stakeholders and perspectives. Several presentations provided an overview of the hydrology of the Oswego River Basin, the current management scenario, and an administrative model (Susquehanna River Basin Commission) for river-basin management and conflict resolution. Seven key issues or needs were identified through facilitated discussions and small work groups. These included enhancing:

1. Public education (about hydrology and human effects on a watershed).
2. Data gathering, sharing, and synthesis (Information is commonly inadequate and dispersed).
3. Coordination of watershed-management goals and activities.
4. Flood mitigation through land-use planning.
5. Trust among stakeholders (The need to use credible sources of information and structured processes to facilitate discussion).
6. Emergency response to flooding (through monitoring, media involvement, duplicating procedures that have been successful in the past, and coordination among agencies and sharing responsibilities).
7. Natural-resource and water-quality protection (by assessing the current status of these resources, setting priorities, and securing financial support to maintain and protect these resources).

Participants identified initial steps toward resolving some key issues. Together, the steps suggested a useful approach, while realizing that no single step or group can attain the objectives alone. Participants agreed that a continuous, constructive dialogue on the issues is needed.

Co-sponsors for this Fact Sheet include: The Soil and Water Conservation Districts of Oneida, Seneca, Steuben, Tompkins, and Yates Counties; the Water Quality Co-ordinating Committees of Chemung, Oswego, and Schuyler Counties; the Cayuga County Water Quality Management Agency; the Ontario County Water Resources Council; and the Madison County Planning Department.