5-2011

Cattails as far as the eye can see

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Repository Citation

Wilcox, Douglas A., "Cattails as far as the eye can see" (2011). *Environmental Science and Ecology Faculty Publications*. 93.
https://digitalcommons.brockport.edu/env_facpub/93

SOCIETY OF WETLAND SCIENTISTS

SWS Research Brief

May 2011 | Special Life Member Series | No. 2011-0002

Cattails as Far as the Eye Can See

Background

Standing on the shores of the Great Lakes in North America, you might think that the shoreline has always been in its present location. However, you would be wrong. Water levels in the Great Lakes have changed dramatically in the past as climate varied naturally over time. As water levels rose and fell, the position of the shoreline shifted. Plant and animal communities of the Great Lakes thus evolved to adjust to the continual fluctuation in water level (and changes in shoreline). The biological effects of fluctuating lake levels are greatest in wetlands, where even small changes can result in conversion of open water to mudflat, or vice versa, thus affecting the diversity and health of plant communities and the habitats they provide for animals.

Regulation of Lake Ontario water levels, beginning around 1960 following construction of the St. Lawrence Seaway, reduced the range of annual variability from 1.5 m to 0.7 m. Low lake levels during the growing season no longer occur, even in low water-supply years.

Past studies identified a resultant alteration of wetland plant communities, especially invasion by cattails. The five-year Lake Ontario-St. Lawrence River study (LOSLR) sponsored by the U.S./Canadian bipartisan International Joint Commission (IJC) provided an opportunity to explore the effects of lake-level regulation on wetlands in much greater detail. It also fostered development of predictive models for evaluating the potential effects of proposed new regulation plans on wetland plant communities.

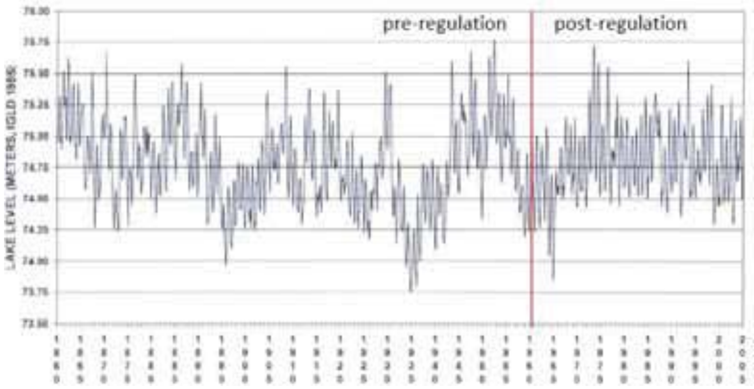
This SWS Research Brief summarizes recently published information (largely directed toward the Great Lakes scientific public) with the intent of presenting it to the larger wetland audience.

Study Goal

The objectives of the wetland portion of the IJC study were to demonstrate quantitative changes in plant communities, determine water-level patterns that best maintain habitat diversity for a variety of fish and wildlife, and develop predictive models and performance indicators to evaluate proposed new regulation plans for Lake Ontario. Specific tasks included evaluating and quantifying vegetation changes using historical aerial photographs; completing a wetland inventory and classification for Lake Ontario and the Upper St. Lawrence River; sampling plant communities that represent unique hydrologic histories; developing bathymetric/topographic models for four Lake Ontario wetland geomorphic types that relate plant communities and animal habitats to water depths, as determined by lake levels; developing preferred water-level regulation plans that would reduce environmental damage; and using the models and study results to predict the potential effects on wetlands of all proposed new water-level regulation plans.

Study Area

The 32 study sites selected for this work were distributed across the Lake Ontario – Upper St. Lawrence River area and included eight wetlands of each of four geomorphic types: open embayment, protected embayment, barrier beach, and drowned river mouth. Half were in Canada, and half were in the United States. These sites were intended to represent a total of 879 wetlands totaling 25,847 hectares, identified in the wetland inventory.



> *"LACK OF LOW WATER LEVELS ALLOWED CATTAILS, WITH A GREATER REQUIREMENT FOR WATER, TO DISPLACE MEADOW MARSH"*

Methods

Aerial Photograph Interpretation

At approximately decadal intervals, aerial photographs from 1938 to 2001 were used to map historical changes in wetland vegetation types at the 32 study sites using photointerpretation and ground-truthing. The resulting vegetation maps were analyzed using a geographic information system (GIS). Area and percent vegetated cover were calculated for each vegetation category and summarized by site and geomorphic type.

Field Surveys

Bathymetric/topographic data for each site were used to create detailed elevation maps within a GIS model framework. Plant community data were collected by sampling along topographic contours at specific elevations representing different flooding/dewatering histories associated with past lake-level changes. Since the existing wetland vegetation in the lake developed in response to the history of high and low lake levels, the selected elevations reflected lake-level history. The hydrologic conditions at the elevations used for sampling transects A-G were as follows: A) last flooded 30 years ago; B) last flooded 10 years ago; C) last flooded 5 years ago; D) last flooded 1 year ago and last dewatered during growing season 2 years ago (variable flooding and dewatering over past 3 years; E) last dewatered during growing season 4 years ago; F) last dewatered during growing season 38 years ago; G) last dewatered during growing season 68 years ago.

Development of Predictive Models

To assess proposed new regulation plans, GIS-based predictive models were constructed by building individual site elevation models and generalized models representing each geomorphic type. Wetland plant profiles were then assigned to the models based on field survey data that related to past flooding/dewatering events.

The output from the models was in the form of percent of wetland area predicted to be in each plant community type across a 101-yr period of past water supply.

The best indicator of the effect of regulation on wetlands was the percentage of wetland in sedge/grass meadow marsh in years following low water supplies. An unregulated lake would have low water levels in those years that would promote growth of sedges and grasses, so plans that more closely mimicked this natural response to low supplies would result in more meadow marsh.

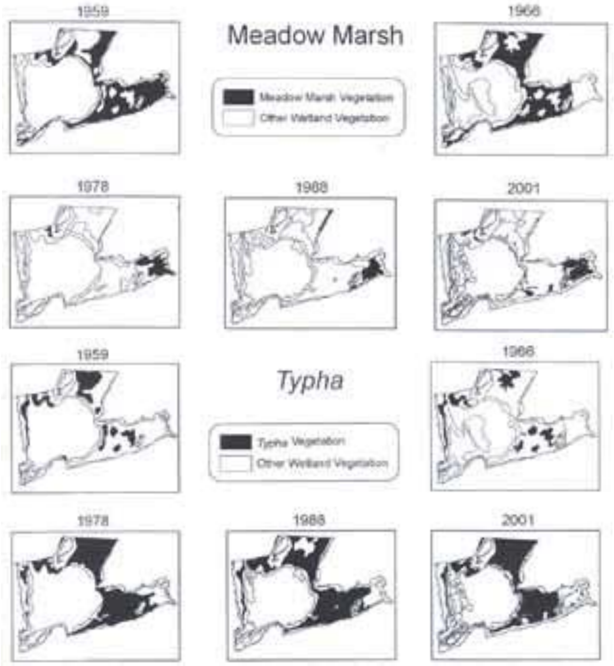
The predictive models were then used to test four proposed new plans for regulation of lake levels (A+, B+, D+, 2007) and to make comparisons with the current plan (1958DD) and unregulated conditions. Plan B+ was developed to enhance the environment by increasing variability; Plan A+ enhanced economic benefits and maintained reduced variability; Plan D+ blended economic and environmental benefits while attempting to minimize losses to each; and Plan 2007 was developed as a compromise among plans.

Findings

Aerial Photograph Interpretation

In-depth analyses of aerial photographs spanning a period from the 1950s to 2001 showed that meadow marsh was the most prominent vegetation type in most wetlands in the late 1950s when water levels had declined following highs in the early 1950s. Meadow marsh increased at some sites during low levels in the mid-1960s and decreased at all sites in response to high lake levels in the 1970s. Meadow marsh continued to decrease and cattail to increase at most sites during sustained higher lake levels through the 1980s, 1990s, and into 2001.

Site-by-site analyses showed that most vegetation changes could be correlated with lake-level changes and with life-history strategies and characteristics of individual plant species, especially tolerances to water depth.



Meadow marsh loss and cattail increase at South Colwell Pond, 1959-2001

Braddock Bay
Open Embayment

East Goose Bay
Protected Embayment

South Colwell Pond
Barrier Beach

Stony Creek
Drowned River Mouth

Analyses of GIS coverages of the meadow marsh and cattail vegetation types demonstrated that much of the cattail invasion was landward into meadow marsh, largely by hybrid cattail. Lesser expansion toward open water included both hybrid and narrow-leaf cattail.

The results suggest that canopy-dominating, moisture-requiring cattails were able to invade meadow marsh at higher elevations because sustained higher lake levels allowed them to survive and outcompete sedges and grasses that can tolerate periods of drier soil conditions.

Cattail invading meadow marsh

Field Surveys

In general, the plant communities at elevations that had not been flooded for five or more years (transects A, B, C) were dominated by sedges and grasses, and those that had not been dewatered for 4–39 years (E and F) were dominated by cattails. The intervening transect D that was intermittently flooded and dewatered over a five-year span contained a combination of sedges, grasses, cattails, and other emergent species. Plant communities that had not been dewatered in the growing season for 40 or more years (G) were dominated by floating and submersed species.

Predictive Models

In years when reduced water supplies would allow meadow marsh regeneration, the models predicted that simulated unregulated lake levels would produce the most meadow marsh in all wetland geomorphic types; current regulation Plan 1958DD would produce the least. Overall predicted percent meadow marsh under the test plans decreased in the order B+, 2007, D+, and A+; the latter three plans with reduced variability produced rather similar results. Lower percentages of meadow marsh under some plans were due to lack of lake levels low enough to allow soils to dry and restrict invasion by cattails, as well as lack of periodic high levels that could kill invading upland plants.

Significance

The development of quantitative relations between water levels and wetland plant communities, generalized geometric wetland elevation models, and estimates of wetland area within the study region provides powerful predictive tools to evaluate potential impacts of alternative water-level regulation plans on Lake Ontario – Upper St. Lawrence coastal wetland habitats.

Moderation of lake-level fluctuations since regulation began has significantly restricted the long-term hydrologic environment important to maintain meadow marsh communities. Moderation of long-term fluctuations also created hydrologic conditions that supported expansion of aggressive cattails and reduction of species richness. Reduction in wetland habitat quality was likely further magnified at sites that were also impacted by stressors such as increased nutrient and sediment inputs from surrounding land uses.

At most sites, the increase in cattail-dominated area did not result from lakeward expansion; it was the result of hybrid cattail invasion into existing meadow marsh at higher elevations.

Lack of low water levels since the mid-1960s seemingly allowed cattails, which have a greater requirement for water, to displace meadow marsh at higher elevations. As a result, more than 50% of the meadow marsh area that occurred within the Lake Ontario – Upper St. Lawrence River basin during the mid- to late 1960s has been replaced by cattail-dominated emergent marsh. At many study sites, the loss in area of meadow marsh vegetation since the 1960s exceeds 80%.

The major differences between the current and proposed regulation plans is their ability to allow low lake levels to occur during periods of low water supply. The mechanisms that drive environment Plan B+ provide both high and low lake levels across the 101-year study period. The mechanisms behind the other plans, including compromise Plan 2007, restrict the range of fluctuations. Thus, Plan B+ is predicted to create 1317 ha more meadow marsh lakewide than Plan 2007 in response to low net basin supplies. Seasonal high and low lake levels that affect habitat for fish and wildlife represent more differences between Plans B+ and 2007. The model evaluations demonstrated that increases in meadow marsh require periodic high lake levels followed by a period of several years of low lake levels, which is consistent with the photointerpretation studies and current general knowledge of Great Lakes wetland processes.

The predictive models for wetland plant communities provided valuable input into International Joint Commission deliberations on new regulation plans and were also incorporated into faunal predictive models used for that purpose. However, the IJC must evaluate the interests of all stakeholders and avoid undue impacts to any interest. The initial IJC selection of Plan 2007 was subsequently withdrawn, and further deliberations on revisions of environment Plan B+ are taking place.

Additional Information

Sedge/grass meadow marsh

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Acknowledgments: The results described above were obtained in collaboration with Martha Carlson Mazur, Morgan Crutcher, Greg Grabas, Holly Hoare, Krista Holmes, Joel Ingram, Kurt Kowalski, James Meeker, Nancy Patterson, and Yichun Xie.

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