Environmental Flows for the Huron River System

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Executive Summary

Introduction

This project aimed to provide the client, the Huron River Watershed Council (HRWC), with a framework for assessing flow alteration and its impact on the biological community of the Huron River. Flow alteration due to indirect and direct effects, especially dams, has occurred over time as human demands on the system have increased. The extent of flow alteration and the feasibility of restoring it to a more natural flow regime depend on the particular characteristics of the system, as well as the historic and current conditions. To assess the impact of flow alteration within the watershed, analyses on annual, monthly, daily and sub-daily hydrological data, precipitation, land cover change, and fish and benthic invertebrate communities were conducted.

Objectives

The objectives of this report were framed by the following three research questions:

1. What are the historical drivers of flow alteration within the Huron River?
2. What are the ecological implication of flow alteration within the Huron River?
3. What are potential options for addressing the altered flow regime?

Key Findings for Long Term Flow Analysis:

- Average annual flow rate has a significant and gradual upward trend for the nearly past 100 years.
- Except March and April, all other calendar months show a significant and gradual upward trend in the mean or median flow rate. November and December show the largest increasing rate.
- The minimum flow magnitudes have significant and gradual upward trend, while maximum flow magnitudes also show an upward pattern although it is not statistically significant.
- If this trend continues to increase, this could mean higher probability of flood events of Huron River in the future.

Key Findings for Precipitation Analysis:

- 8% increase in precipitation from 1949-1980 to 1981-2013
- Average yearly precipitation is 29.8 inches (1949-2013)
- Runoff coefficient around 0.35
- All the gauges show significant increases from 1915 to 2013
- Precipitation is positively correlated to flow rate, indicating that increase in precipitation is likely driving flow increase.

Key Findings for Short Term Flow Analysis:

- Ann Arbor gauge and Ford Lake Dam have a higher flashiness compared to other gauges. New Hudson also displays high flashiness during April and November. These high flashiness

could be resulted from dam regulations
- Hamburg generally has the lowest flashiness among all gauges, which could be similar to the natural flow regime of Huron River.
- The automatic control system of Argo Dam, the cascade, and inflow from Allen Creek could be the cause of high flashiness in Ann Arbor gauge.

Key Findings for Land Cover Analysis:

- There is a substantial increase in runoff potential from pre-settlement to current day caused by land cover change
    - For the Ypsilanti catchment of the Huron River watershed, the runoff curve number has increased from 62.39 in pre-settlement conditions to 72.77 in 2006 land cover conditions
- In recent history there has been a decrease in runoff potential due to land cover change
    - For the Ypsilanti catchment of the Huron River watershed, the runoff curve number has decreased from 73.78 in 1992 land cover conditions to 72.77 in 2006 land cover conditions

Key Findings for Benthic Invertebrate and Habitat Analysis:

- Urbanization is the major stressor on stream habitat quality in terms of land use change
- Increase of developed land changed the stream habitat by fine sediment input, habitat diversity decrease and riparian vegetation zone degradation
- Change in stream habitat is highly correlated with the quality of benthic invertebrate communities

Key Findings for Fish Community Analysis:

- Distinct difference between riverine and impoundment fish samples
- 18 fish species only found in riverine sections (ROG or Riverine Only Guild)
- 15 fish species only found in impoundment sections (IOG or Impoundment Only Guild)
- 22 crossover species, which were found in both riverine and impoundment sections
    - ROG and IOG were distinct in the following preferences/characteristics: species of status, game fish, darters, tolerance, lake dwellers, river size, substrate, flow velocity, and trophic guild
- Habitat evaluation, conducted using MDNR's Lake IBI for impoundments and MDEQ Procedure 51 for riverine sites, requires more analysis and higher quality/more recent data, but seems to suggest that impoundments act as fair to poor lake-like structures and riverine sites generally agree with HRWC habitat assessments. However, it is important to note that riverine habitat quality did not demonstrate a pattern of degradation with respect to impoundment proximity. Ground-truthing could help reveal whether these results reflect real changes in stream habitat or are a consequence of fish sample methodology or some other factor.

Key Findings for Habitat Suitability Model:

- Fish communities around Ann Arbor and Ypsilanti are not in agreement with predicted model communities given the catchment size, July mean water temperature, and base flow yield.
- Present fish communities prefer a flow range with a higher upper bound for high flows and lower for low flows relative to model communities at the Ann Arbor and Ypsilanti sites.
- An adverse resource impact (ARI) occurs in Ann Arbor at a low flow of 45.3 cfs and in Ypsilanti of 51.7 cfs.
- Ann Arbor has the highest amount of historic ARI causing flow occurrences throughout the Huron River, indicating that it is necessary to prioritize associated dam operations.
- Suitable and preferred flow ranges were determined for Model and Game target fish communities for each dam from Barton Pond to Ford Lake as a means to manage flows influenced by these dams.

Recommendations:

- Average flow and baseflow have an upward trend for the past 100 years, while precipitation also has an upward trend for the past 100 years, suggesting that precipitation could be the driving force for the flow increase. Additionally, the upward trend in flow rate could mean higher probability of flood events in the future.
- Daily and subdaily flow analysis show that gage near Ann Arbor and Ford Lake Dam has high flashiness. The high flashiness in Ann Arbor could be the result from the automatic control system in Argo Dam.
- Increase in the runoff curve number due to land cover change has locally influenced the low and peak flows associated with precipitation events.
- Invertebrate taxa were found to be impacted by urbanization due to increased flashiness, impaired water quality, and loss of habitat diversity, which is likely also influenced by dams.
- Summer base flow conditions must be maintained above 45.3 cfs in Ann Arbor and above 51.7 cfs in Ypsilanti.
- Collaborate with City of Ann Arbor to analyze flashiness at Ann Arbor Gage and the impact on biotic communities.
- Collaborate with dam owners to prepare for potential high flood events.
- Collaborate with a regional or local organization to work on a climate model to assist in anticipating future impacts of increased flow.
- Work with stakeholders to determine desired fish communities and collaborate with dam owners to encourage the desired community through amendments to operations.

Future Work:

- Further collaboration and transparency with dam operators, especially detailed strategies of dam operations, would assist in understanding how dams are impacting the ecological community and what strategies could be employed to amend current operations.
- Ideally, more stream gages at both riverine and impoundment sites (i.e. directly below dams, especially hydroelectric dams, which cause more flashiness) would provide more information

on dam operation and the impact of sub-daily flows. In particular, a stream gage directly below the Argo Dam would help determine the impact of the Cascades.

- Future studies should identify the cause of flashiness downstream from Argo Dam and its impact on the local biological community.
- In terms of precipitation, the role of evapotranspiration and anthropogenic impacts also can affect runoff increase and should be explored.
- Ideally, local/regional precipitation data, more data on soil type and slope, as well as the integration of a groundwater model could help better evaluate the impacts of precipitation and the timing and movement of water through the hydrologic system.
- Ideally, fish and invertebrate samples, flow gage data, and habitat evaluations should be conducted simultaneously at the same riverine and impoundment sites, so that multiple lines of evidence could be used to explore the impact of abiotic factors on the biotic community.
- The fish sample data suggests that riverine sites, with characteristic riverine fish species, can exist between impoundment sites, but more research is necessary to determine what factors - reach length, habitat quality, flow regime, etc. - are influencing these sites and fish communities.
- Depending on management objectives, potential benefits of restoring/improving fish habitat in culturally or economically entrenched impoundments should be explored, since this might promote populations of the IOG and crossover species.
- Future fish studies should explore species requirements/preferences throughout their life cycle and consider the current velocity limits on habitat suitability.