Management of passive infrastructure such as small dams is often based on rough estimates and professional judgement of system response.
Introduction

• Poor management can lead to unintended downstream (or upstream) consequences.

Low Flow (Image Credit)  Bank Erosion (Image Credit)
DAM Dashboard Concept

- DAM Dashboard establishes an information network for dams and other infrastructure.
DAM Dashboard Concept

- DAM Dashboard combines monitoring data and forecasts to recommend management actions.
Applications / Benefits

- **DAM Dashboard Goal**: Improve management through informed decision making

- **Water Supply**
  - Drought management
  - Improve streamflow

- **Lake Management**
  - Drawdown compliance
  - Wetland permit compliance

- **Flood Control**
  - Reduce Flood Damage Risk
  - Minimize Downstream Erosion
Stony Brook Flow Restoration Project

(Pictured: Mill Pond Dam, 4/4/2018)
Study Area
• Water supply source basins are stressed

• Requirement to minimize impact of groundwater withdrawals
Streamflow along mainstem is often low throughout watershed

(Pictured: Spectacle Pond Outlet, Drought Conditions, 9/27/2016)
Collaborate with stakeholders to improve streamflow through coordinated operation of existing impoundments using decision support tools informed by model results, streamflow data, and weather forecasts.

- Outcomes
  - Calibrated Model
  - Operational Goals
  - Monitoring Network
  - Operational Strategies
  - Decision Support Dashboard
  - Improved Streamflow Management!
Stony Brook: Project Workflow

Collect Data

Engage Stakeholders

Develop Model

Test Strategies

Provide Decision Support Tools
Project Initiation: Goal Setting

(Pictured: Forge Pond Dam, 8/2/2017)
Goal Definitions

• Overarching goal to mimic “natural” streamflow conditions without compromising other in-lake uses and stakeholder concerns

<table>
<thead>
<tr>
<th>Goals</th>
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<tbody>
<tr>
<td>Mimic Natural Conditions</td>
</tr>
<tr>
<td>Maintain Streamflow</td>
</tr>
<tr>
<td>Improve Storm Resiliency</td>
</tr>
<tr>
<td>Protect Fish Populations</td>
</tr>
<tr>
<td>Control Vegetation</td>
</tr>
<tr>
<td>Maintain Recreational Uses</td>
</tr>
</tbody>
</table>
• Developed Simplified Streamflow and Water Level Thresholds to Evaluate Goals at Each Impoundment
Example Indicator Thresholds

(Upsream – Pond)

High Level Range

2-yr Storm Elevation

Spillway Elevation

Normal Level Range

Recreation Issues

Low Level Range

(Downstream – Channel)

Peak Allowable Drawdown Flow (4 cfs)

Aquatic Base Flow (0.5 cfs)

Normal Flow Range

Low Flow Range

High Flow Range

Dam/Outlet
Potential Operational Adjustments

Goal:
Improve coordinated operation of existing infrastructure

Make Adjustments Simple and at a Reasonable Frequency
Model Development
(Pictured: Stony Brook Dam, 4/5/2018)
Existing Conditions Model

- Developed to enable testing of evaluation strategies (Model: EPA SWMM 5.1)
Existing Conditions Simulations – Spectacle Pond

- Simulations take into account seasonal drawdown and refill

![Graph showing seasonal changes in pond levels](image-url)

- **Spillway**
- **Navigation Issues**
- **Winter Drawdown Level**
- **Spring Refill**
- **Winter Drawdown**
- **Increase from Precipitation**
Operational Strategy Development

- Developed three (3) model iterations to test potential streamflow improvements

- Simplified logic sequence for selected iteration:
Example Logic Sequence

- **High Level Range**
- **Spillway Elevation**
- **Normal Level Range**
- **Recreation Issues**
- **Low Level Range**

2-yr Storm Elevation

- **Initiate Monitoring**
- **Wait**

- **Dam/Outlet**
- **Peak Allowable Drawdown Flow (4 cfs)**
- **High Flow Range**
- **Normal Flow Range**
- **Low Flow Range**

Aquatic Base Flow (0.5 cfs)

Low Flow Range
Example Logic Sequence

Streamflow Dropping

- **High Level Range**
- **2-yr Storm Elevation**
- **Spillway Elevation**
- **Normal Level Range**
- **Recreation Issues**
- **Low Level Range**

- **Peak Allowable Drawdown Flow (4 cfs)**
- **Normal Flow Range**
- **Aquatic Base Flow (0.5 cfs)**
- **Low Flow Range**

**Wait**
Example Logic Sequence

Low Flow Reached, Initiate Release

- **Peak Allowable Drawdown Flow (4 cfs)**
- **Aquatic Base Flow (0.5 cfs)**
- **Normal Flow Range**
- **Low Flow Range**

---

**High Flow Range**

**Normal Level Range**

**Spillway Elevation**

**2-yr Storm Elevation**

**Low Flow Reached, Initiate Release**

**Dam/Outlet**

**Release**

**Recreation Issues**

**Low Level Range**

**High Level Range**
Example Logic Sequence

Normal Flow Reached, Continue Releasing

- High Level Range
- 2-yr Storm Elevation
- Spillway Elevation
- Normal Level Range
- Recreation Issues
- Low Level Range

Dam/Outlet

- Release
- Peak Allowable Drawdown Flow (4 cfs)
- Aquatic Base Flow (0.5 cfs)
- Normal Flow Range
- Low Flow Range
- High Flow Range
Example Logic Sequence

Approaching Low Water Level

- **High Level Range**
- **Normal Level Range**
- **Low Level Range**

2-yr Storm Elevation

Spillway Elevation

Recreation Issues

Peak Allowable Drawdown Flow (4 cfs m)

Aquatic Base Flow (0.5 cfs m)

High Flow Range

Normal Flow Range

Low Flow Range

Release

Dam/Outlet
Example Logic Sequence

Low Water Level Reached, Halt Release

- High Level Range
- Normal Level Range
- Low Level Range

2-yr Storm Elevation
Spillway Elevation

Halt

- Peak Allowable Drawdown Flow (4 cfs/m)
- Aquatic Base Flow (0.5 cfs/m)
- Normal Flow Range
- Low Flow Range

Recreation Issues

Low Water Level Reached, Halt Release
Results

(Pictured: Depot Dam, 4/5/2018)
Result Takeaways

1. Streamflow improvements were simulated at all locations.
2. All impoundments are susceptible to low downstream flow resulting from prolonged dry periods.
3. Model simulations are sensitive – empirical testing is needed to validate results.
Example Model Results - Streamflow

Spectacle Pond Streamflow Exceedance Curve - 2016

Baseline Conditions: Aquatic Baseflow Exceeded 48% of time
Proposed Conditions*: Aquatic Baseflow Exceeded 73% of time
Improvement = 25%

“Normal” Flow Range

*Proposed Conditions = Iteration 3

GEOSYNTEC CONSULTANTS
### Streamflow Exceedance Results

<table>
<thead>
<tr>
<th>Year</th>
<th>Impoundment</th>
<th>Percent of Time Simulated Downstream Streamflow is &quot;Normal&quot;</th>
<th>Percent Improvement from Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Baseline</td>
<td>Iteration 1</td>
</tr>
<tr>
<td>2016</td>
<td>Mill Pond Dam</td>
<td>37%</td>
<td>60%</td>
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<tr>
<td></td>
<td>Spectacle Pond Outlet</td>
<td>48%</td>
<td>73%</td>
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<tr>
<td></td>
<td>Forge Pond Dam</td>
<td>54%</td>
<td>62%</td>
</tr>
<tr>
<td></td>
<td>Stony Brook Dam</td>
<td>56%</td>
<td>76%</td>
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<tr>
<td></td>
<td>Depot Dam</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Brookside Mills Dam</td>
<td>47%</td>
<td>67%</td>
</tr>
<tr>
<td>2017</td>
<td>Mill Pond Dam</td>
<td>64%</td>
<td>74%</td>
</tr>
<tr>
<td></td>
<td>Spectacle Pond Outlet</td>
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<td>Depot Dam</td>
<td>74%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Brookside Mills Dam</td>
<td>77%</td>
<td>84%</td>
</tr>
</tbody>
</table>
Monitoring and Decision Support

(Pictured: Brookside Mills Dam, 4/5/2018)
Monitoring Station Locations

- Forge Pond Dam
- Spectacle Pond Outlet
- Stony Brook Dam (Westford)
- Depot Dam
- Brookside Mills Dam
- Mill Pond Dam

Study Area (38 sq. mi.)
Stony Brook Monitoring Station

- Solar Panel
- Communications Enclosure
- Stilling well with submerged monitoring probe
- Junction Box
• **Provide continuous monitoring data**
  – Water level, discharge estimates, etc.

• **Provide forecast data and predictions**
  – Precipitation (7-day)
  – Predicted impoundment inflow (7-day)

• **Provide decision support email alerts**
  – Based on recommended model Iteration 3
  – E.g., Approaching Critical Streamflow, Initiate Release

• **All stakeholders can opt to receive selected alerts**
Alert Sequence – Low Flow Releases

Alert Sequence

Wait - Approaching Critical Low Flow

Start Release, Critical Low Flow Reached

Continue Release - Approaching Critical Low Water Level

Stop Release, Critical Low Level Reached
Low Water Level, Halt Release! The measured water level of Forge Pond is below 202.5 ft. If a low flow release is currently occurring, mobilize immediately to halt the release.

To unsubscribe from Opti notifications, please email support@optirtc.com.

Click Unsubscribe to stop receiving all alerts from Opti.
Next Steps

(Pictured: Upstream Channel, Depot Dam, 4/5/2018)
Next Steps

- Selected as DER Priority River Restoration Project
- Obtained Additional Funding through Water Management Act Grant Program

(Pictured: Stony Brook Impoundment, 4/5/2018)
Next Steps

• Perform streamflow gauging and additional calibration / validation of model
• Perform baseline stream biota sampling
• Perform low flow feasibility evaluation
  – Obtain owner approval for all locations
  – Obtain state and local approval
• Perform empirical testing and evaluate effectiveness of recommendations
  – Release openings, release thresholds, forecast thresholds etc.
• Evaluate potential for automated controls
• Expand study area
Partners:

Opti

LELWD

Town of Westford
Healthy Lakes and Ponds Collaborative
55 Main Street
Westford, MA 01885

Friends of Forge Pond

Littleton Clean Lakes Committee
PO Box 2406 Littleton, MA 01460 (978) 540-2222

Littleton and Ayer Spectacle Pond Association
7 Baron Way PO Box 23 Littleton, Massachusetts 01460 - 978-580-1343