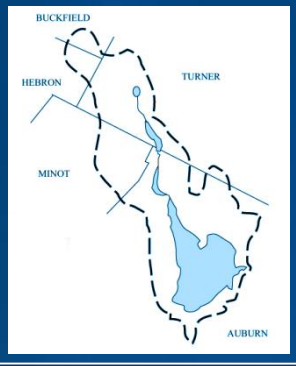

LAKE AUBURN: THE EFFECT OF CLIMATE DRIVERS ON LAKE WATER QUALITY

CDM Smith

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Kenneth Wagner, Water Resource Services

Mary Jane Dillingham, Auburn Water District and Lewiston Water Division

New England Water Environment Association

2015 Annual Conference

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WRS

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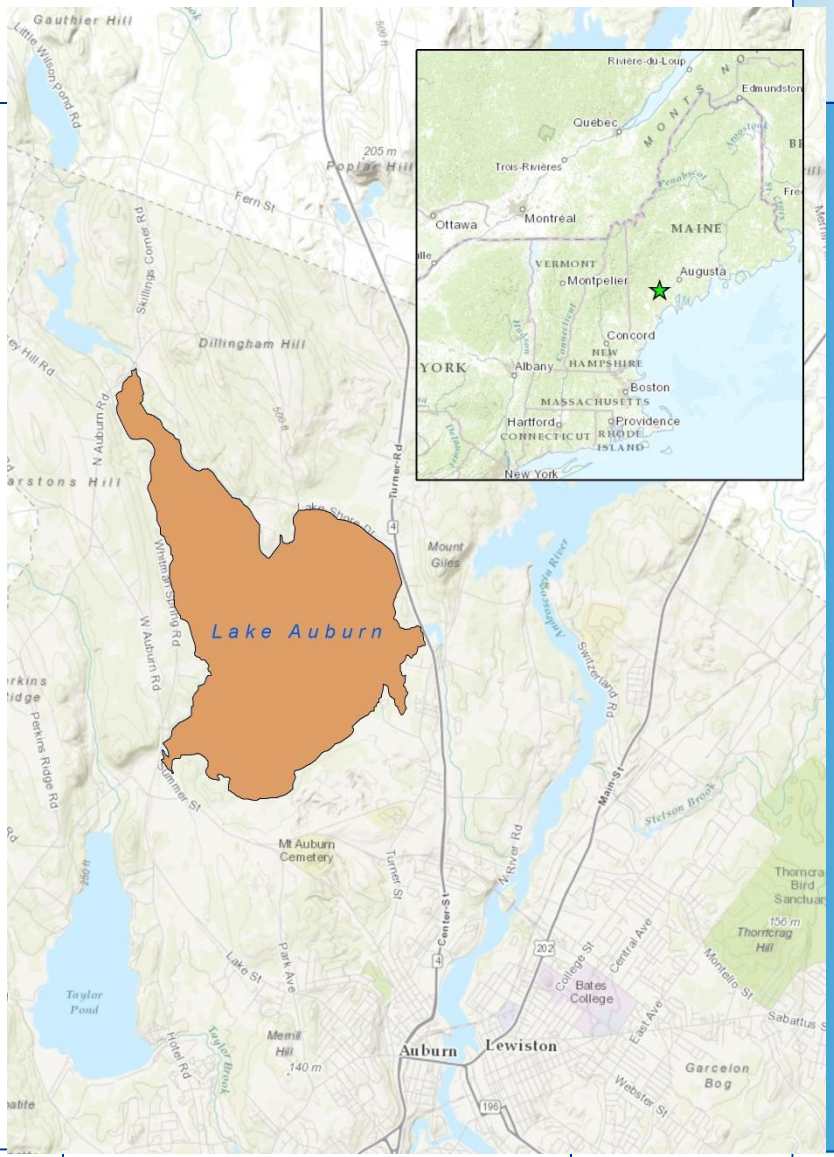
- Eileen Pannetier, Ben Lundsted, Rebecca Balke, Comprehensive Environmental, Inc.

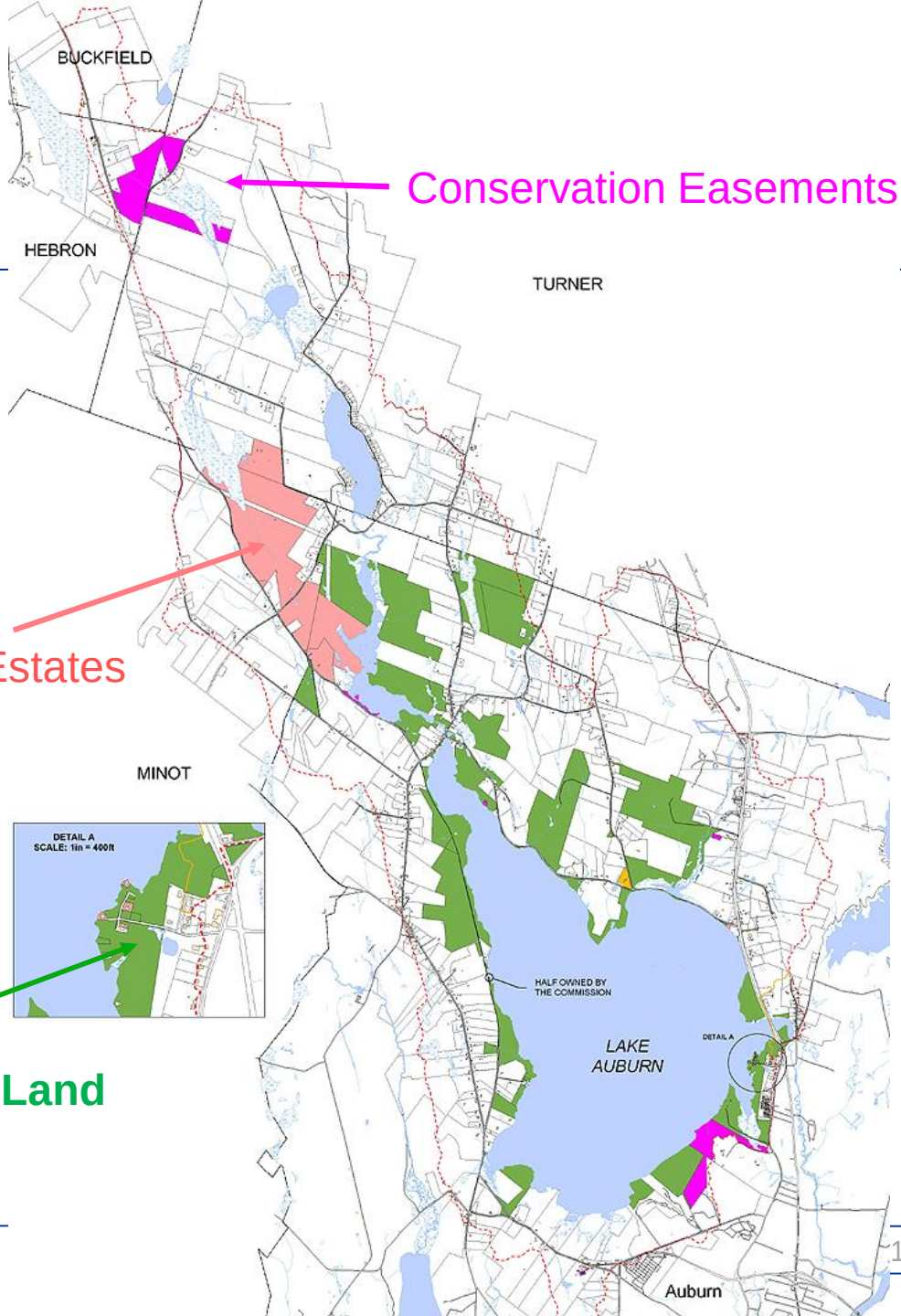
Lake Auburn in Auburn, Maine

- Principal water supply for Lewiston and Auburn, Maine
- Filtration avoidance waiver granted in 1991
- Strong watershed protection program coupled with largely undeveloped watershed has maintained excellent water quality

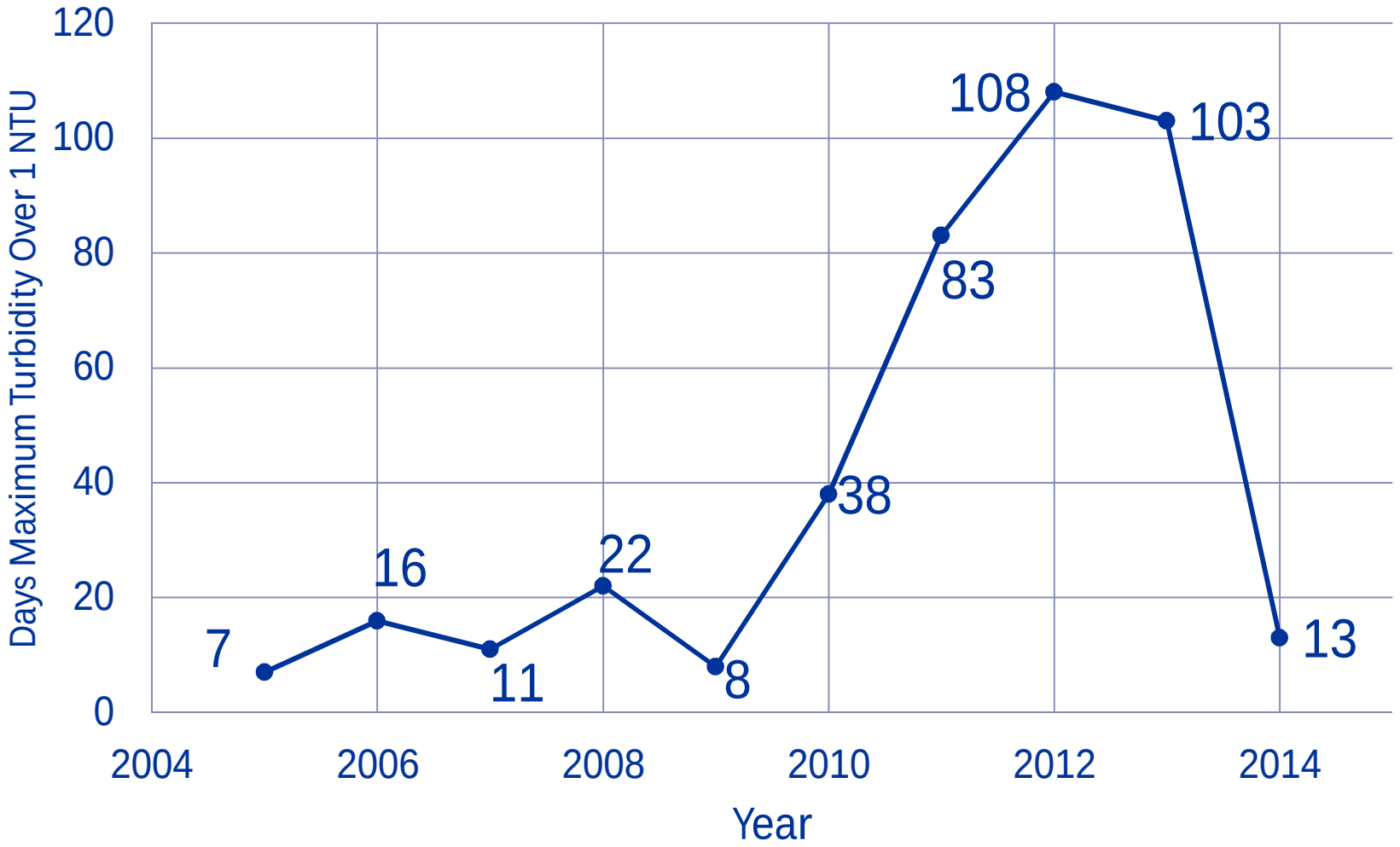


Lake Auburn Watershed

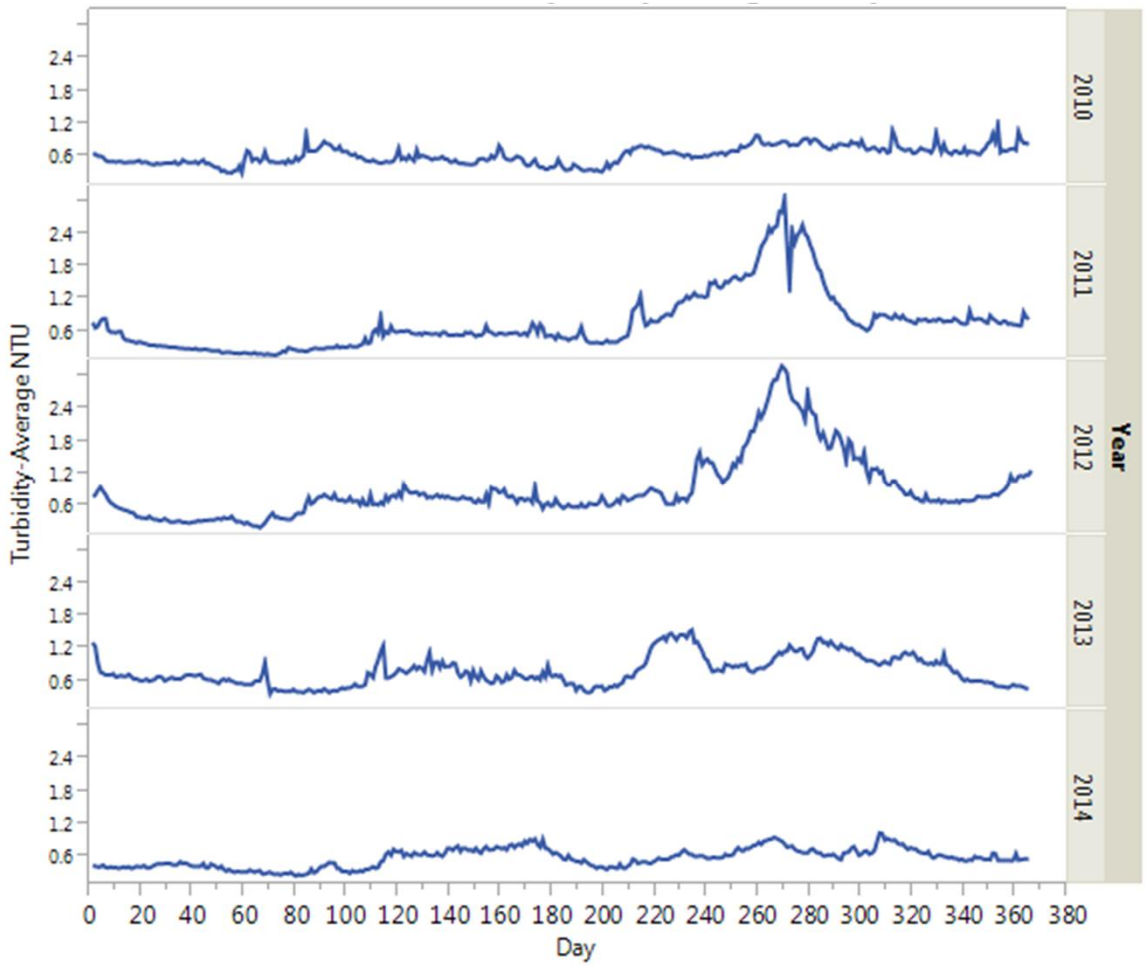
- 21% of watershed protected, including conservation easements



Days Maximum Turbidity over 1 NTU at Intake



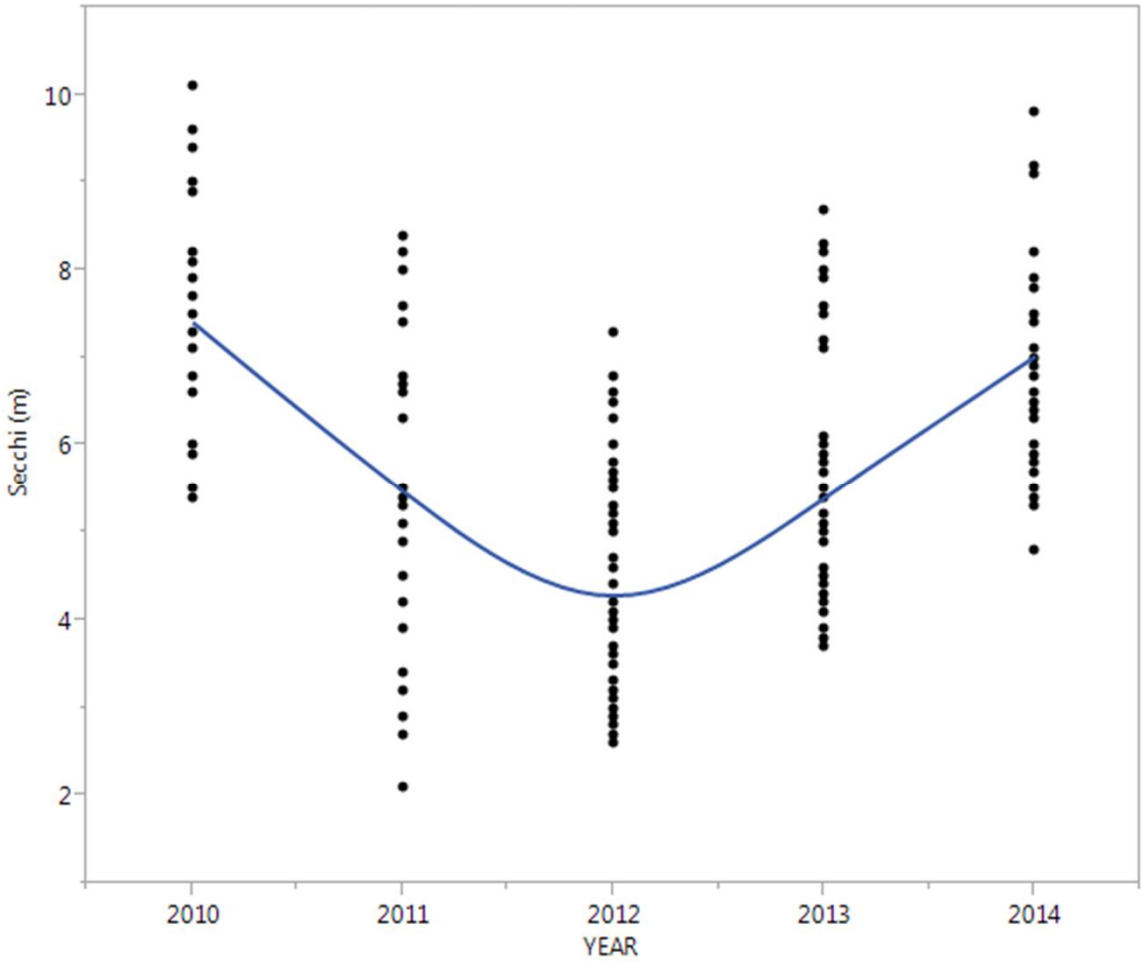
Lake Auburn Turbidity: Daily Average vs. Day



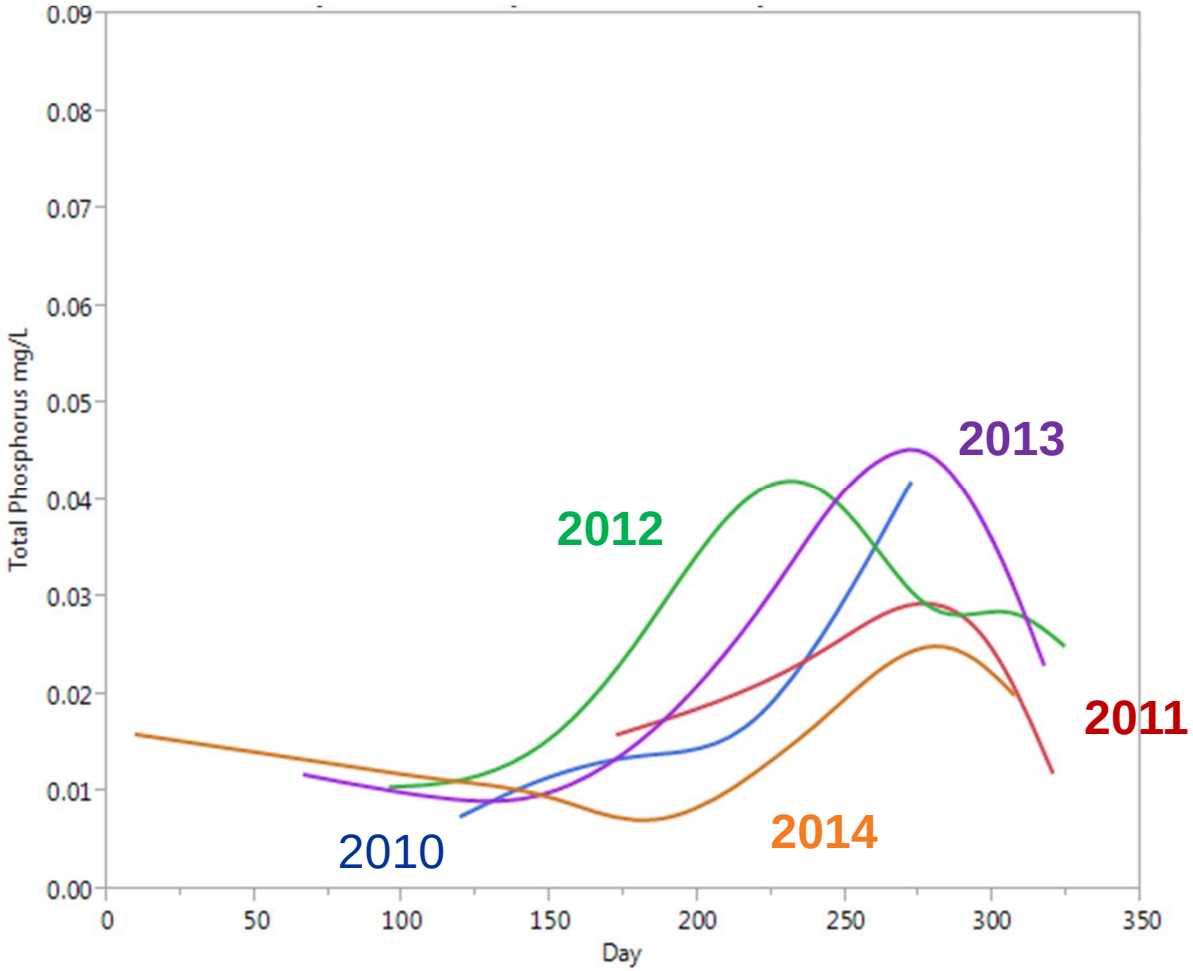
2012 Fish Kill

- First fish kill reported on Lake Auburn
- Over 200 dead or dying fish were recovered
- Do not know how many fish were affected
- Survey by Maine Department of Inland Fisheries and Wildlife found surviving fish in the lake

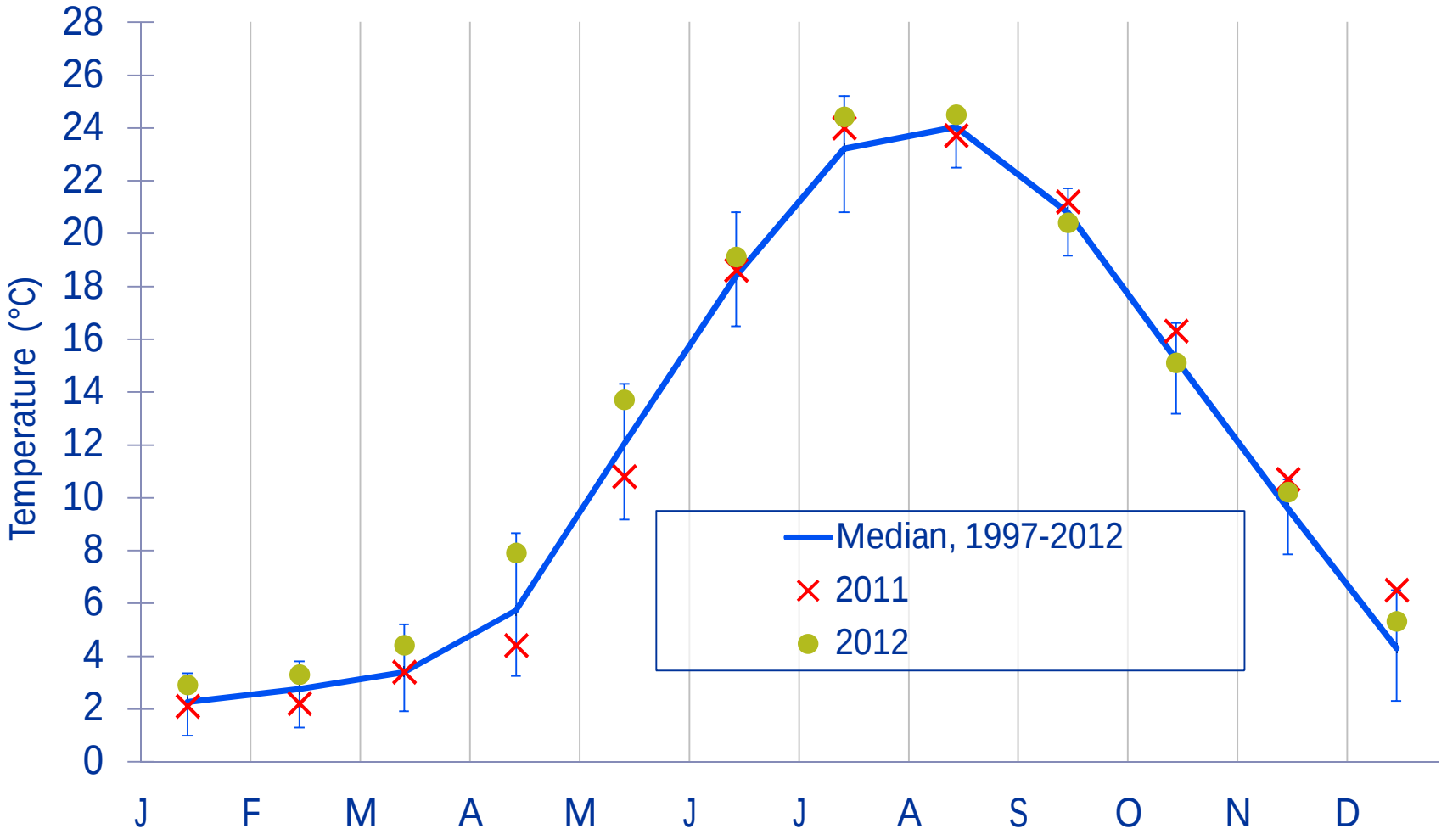
Lake Auburn Transparency at the Deep Hole 2010 - 2014



Total Phosphorus at the Deep Hole
21 to 37 m, 2010 - 2014

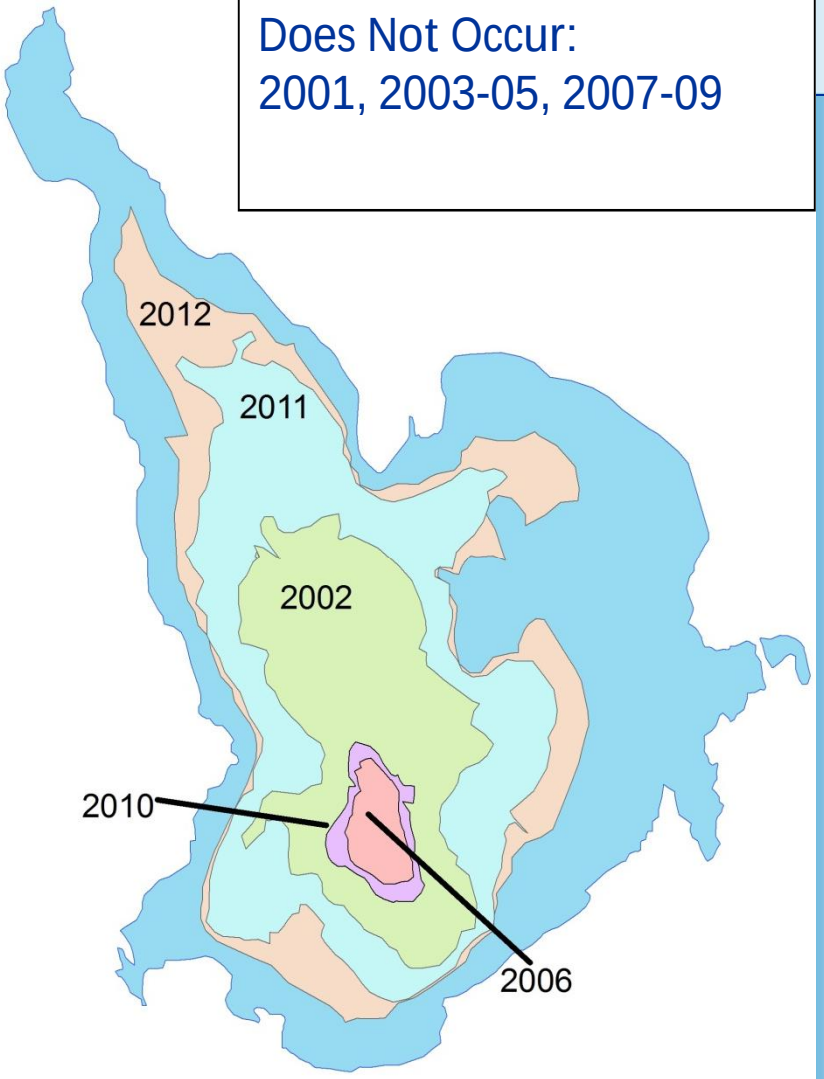


Intake Water Temperature: Near Record Highs

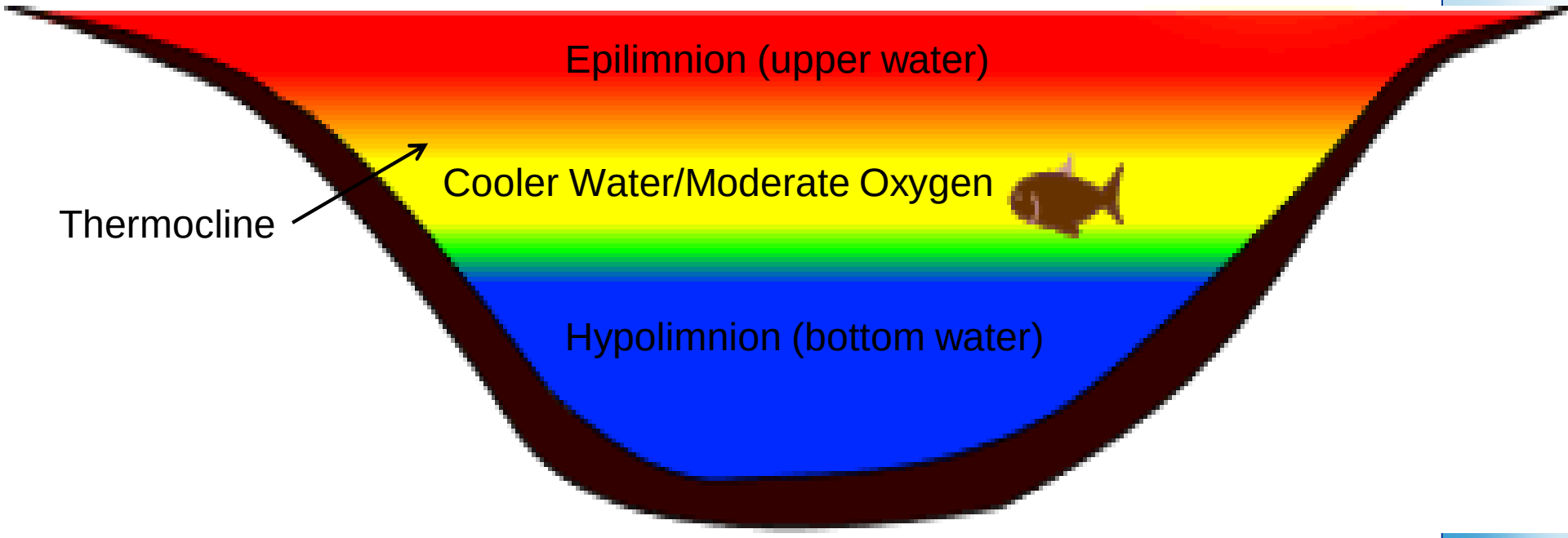


Extensive Areas of Low DO in Bottom Waters

- Area of bottom where dissolved oxygen < 2 mg/l results in:
  - Release phosphorus from sediments into water
  - No habitat for fish and other aquatic life



Factors in 2012 Fish Kill



By late August, 2012, anoxia throughout bottom waters and warm surface water eliminated lake trout habitat

Slide graphic credit: Scott Williams, presentation to the Lewiston City Council on October 9, 2012

Implications for Lewiston and Auburn Water Utilities

- Turbidity approached the regulatory threshold in two consecutive years
  - Per waiver: turbidity cannot exceed 5 NTU on consecutive days (an “event”) unless:
    - State determines caused by unusual and unpredictable circumstances
    - Not more than two events in 12 months or 5 events in 120 months
- If water quality degradation continued:
  - Construction of an advanced water treatment plant could be mandated
  - Taste and odor issues could occur in distribution system
  - Coldwater fishery could be threatened

Long-term Trend? Short-term Changes?

CDM Smith performed diagnostic study

- Examined possible drivers of degradation:
  - Part of a long-term pattern
    - Had the lake reached a tipping point?
    - Were climate change drivers causing ecological shift?
  - Or due to particular within-year phenomena
    - Anomalous storms
    - Near record warm winter in 2012
- Evaluated if degradation would continue

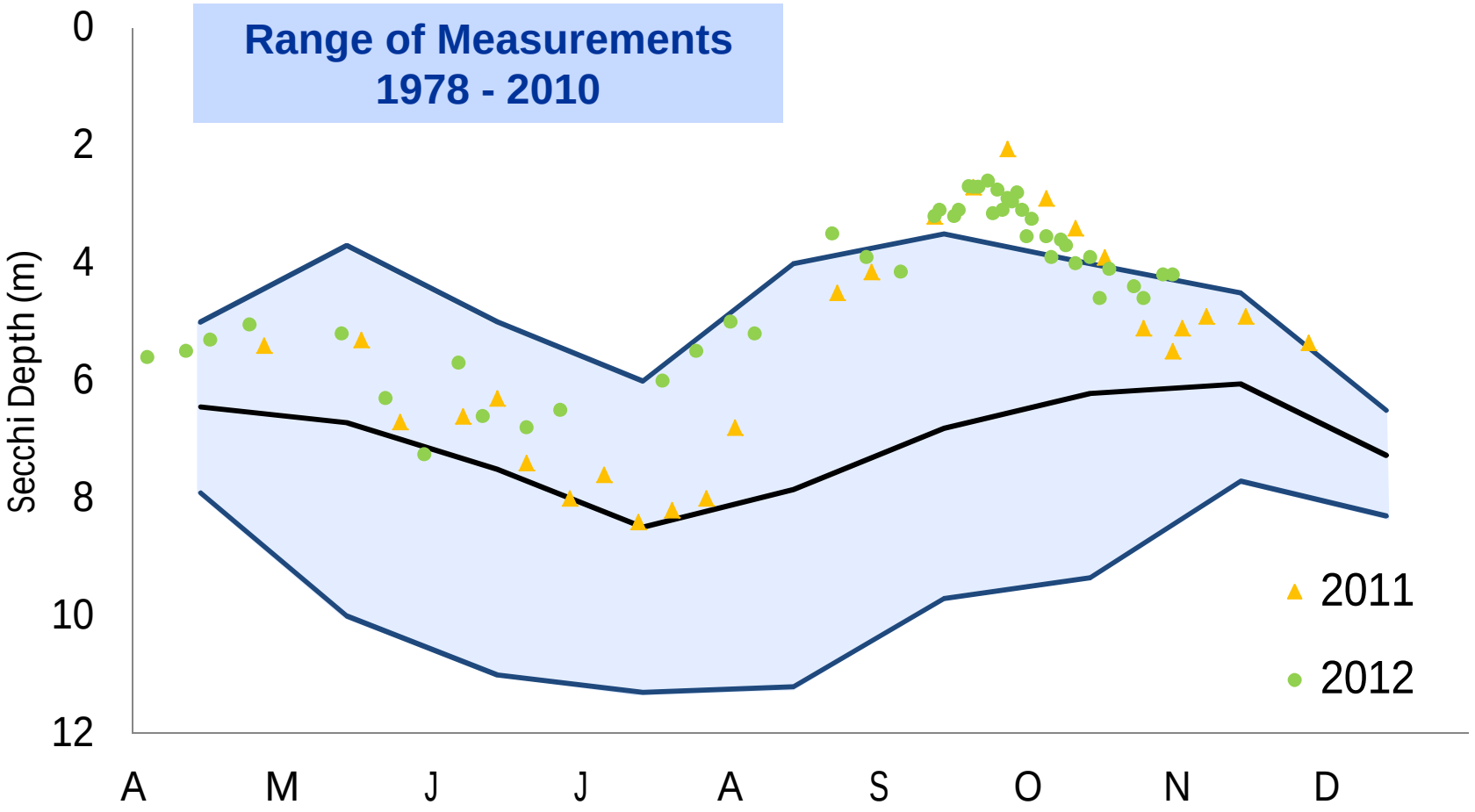
Watershed Analysis and Findings

- Changes in watershed not a key driver in recent lake water quality degradation
  - Strong existing watershed program has provided significant protection
  - Some areas for improved protection identified, particularly regarding storm-driven sediment load

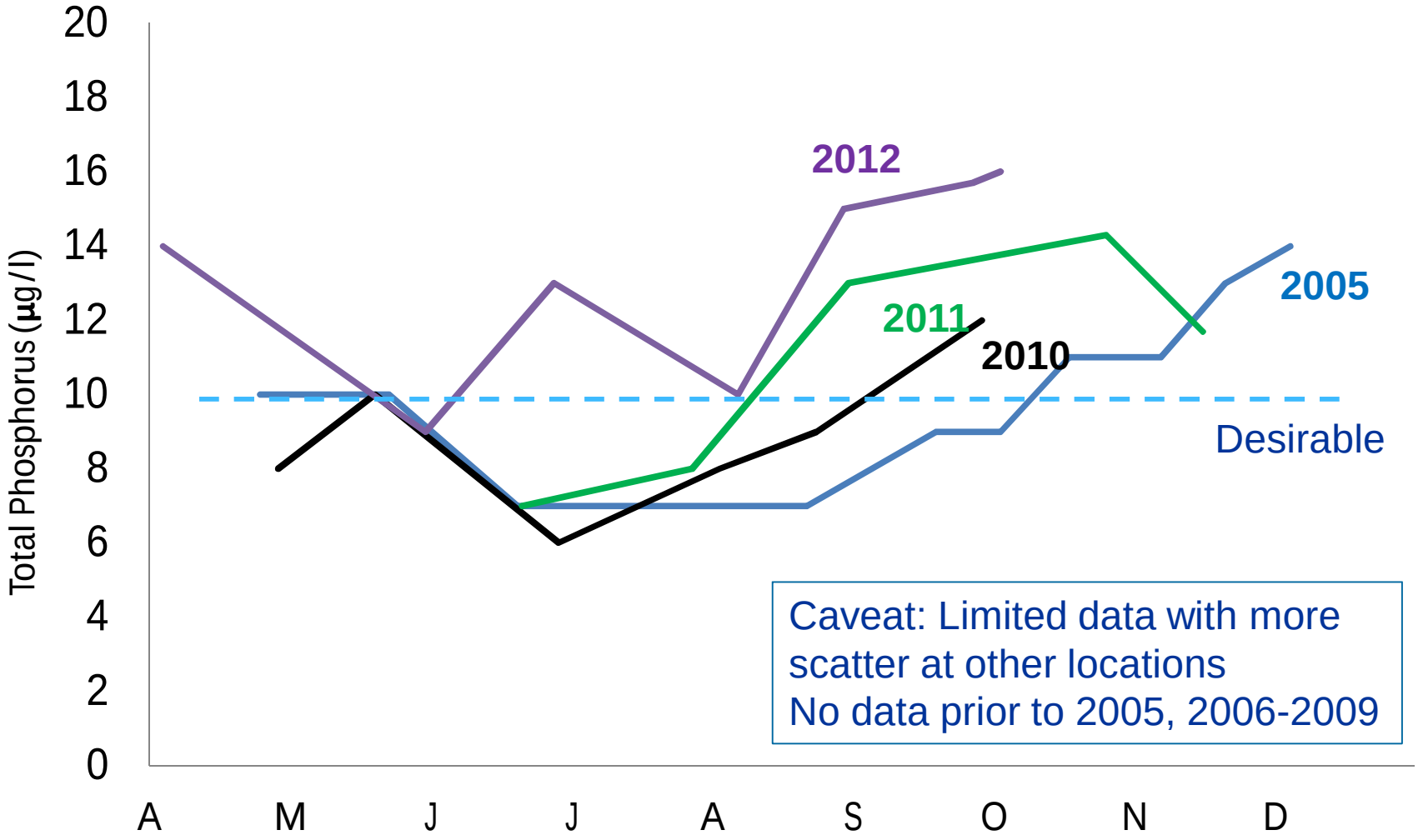
Lake Analysis and Findings

- Diagnostic study of in-lake data to help identify cause of recent degradation
- Examined data describing
  - Surface water temperature trends
  - Low oxygen in bottom water
  - Fish kill
  - Secchi depth
  - Epilimnetic phosphorus levels

Record Shallow Secchi Depth After 2011



Steadily Increasing Epilimnetic Total Phosphorus



Summary of Lake Water Quality Data

- Evidence of decreasing transparency, increasing phosphorus, high sediment phosphorus levels in recent years
- Several sources for apparent increased phosphorus in surface water – watershed load, sediment load
- Available data suggest that the lake is responding to both
  - Forcing factors in current year (storm loads, high temperature)
  - Apparent long-term trends
- Data insufficient to determine which is more significant

How to Protect the Filtration Waiver?

- Need to plan for a long-term management system
  - Hypolimnetic oxygenation
  - Phosphorus inactivation
- Need to plan a short-term contingency measure if algae and high turbidity occur again before long-term management system can be built
  - Applied for and received Maine's first ever copper sulfate algaecide permit to protect and maintain filtration waiver

Which Alternative to Choose?

- Equal scientific merit and similar life cycle costs
  - Both plans reduce phosphorus availability, decrease algal bloom potential, and enhance fish habitat
  - Phosphorus inactivation has a higher up-front cost but no ongoing operational costs
  - Oxygenation has lower up-front costs but does have ongoing operational costs whenever the system is in use
- Selection will require consideration of
  - Trade-off: up-front cost vs. need for annual operations
  - Regulatory approval and stakeholder acceptance
  - Flexibility of operation

Note that options are not mutually exclusive, but cost likely precludes application of both appropriate approaches by the Water District

Lake Auburn in 2013 and 2014

- No algaecide required in 2013 or 2014
- Lewiston and Auburn continue to strengthen watershed protection:
  - Amended regulations to promote LID and reduce runoff to lake
  - Implemented enhanced monitoring program
  - Developed public education program
  - Construction of key, high-priority structural BMPs
- Water quality overall much better than 2011 and 2012
  - Deeper Secchi depth
  - Lower turbidity
  - Less anoxia
  - Lower total phosphorus

What are the Implications for Water Utilities?

- Climate change may bring conditions that foster increased algal productivity:
  - Stronger stratification
  - More intense storms (increased nutrient load)
  - Warmer water
- Important to prepare for these changes:
  - Robust water quality monitoring
  - Identification of long-term management strategy
  - Contingency plan if sudden degradation occurs

Long-term Management Plan Recommendations for Lake Auburn

1. Continue to monitor water quality in lake and watershed
2. Continue to enhance watershed protection program
3. Maintain the ability to apply a copper sulfate algaecide
4. Begin planning for the implementation of in-lake management system
5. If an algaecide is required then implement an in-lake management option by July of the following year

Benefits of this plan to improve water quality will be:

- Safe, affordable drinking water
- A robust and healthy cold-water fishery

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Image credit: http://www.panoramio.com/photo/11474317