The Maine Lake Protection and Research Collaborative (January 2018)

Hundreds of Maine communities rely on clean lakes as their economic backbone. Thousands of people rely on these fragile resources for 'quality of life' activities on or near the water, and many more plants and animals make their homes in their clear, cool, deep waters. Maine lakes and other waters will benefit from a broad-based and comprehensive approach to resource protection and restoration, one that builds on the foundation of protection implemented in the 1970s under the Clean Water Act. Nearly four hundred diverse Maine organizations, including individual lake associations, regional alliances, statewide organizations, and governmental entities, embrace as part of their mission facets of education, monitoring and the safeguarding of water quality. An eye to the future reveals that it is incumbent on these stakeholders to assure that science-based policies are implemented before further damage is done to these precious resources.

A robust multi-disciplinary community of academic researchers, state and federal agency staff and Non-Government Organizations (NGOs) have collaborated with the common purpose of identifying 'needs and barriers' to the protection of Maine's precious lakes. By design, the diversity of participants is an attempt to incorporate perspectives ranging from the social/political sciences to the chemical/physical/biological sciences and recognizes the deep spiritual connection many have with 'their' lakes. This working partnership, the Maine Lakes Collaborative (MLC) is expected to be a powerful force for change by identifying needs and proposing a multipronged strategy for future action.

Members of the MLC have met at least four times to brainstorm ideas, identify needs and begin creating a strategy with which to secure funding for implementation. The strategy envisions formation of multiple teams, each having specific tasks to accomplish. Additional collaborators will be welcomed to the teams and are expected to participate in one or more of tasks for which they are best suited. A steering committee comprised of representatives from the various participating organizations will be established to oversee the progress of the Collaborative, which will be coordinated by Maine Lake Science Center staff. The steering committee will include representatives from the Lake Leaders group, each of the statewide lake organizations, researchers, and state government. Steering committee duties will also include tracking progress on specific grant obligations and allocation of resources.

The MLC identified many opportunities that generally fall under applied science, research science and social science. The following protection and research elements were identified as being high priority for the strategy:

1) Expand monitoring of lakes including water quality parameters, habitat assessments, floristic assessments, toxics evaluation, biological assessments (fish, zooplankton, macroinvertebrates, water-dependent birds) to get a better evaluation of ecosystem health.
2) Expand inventory and accuracy of morphometric and watershed variables used in modeling lake processes, and identify/implement routine summary calculations of water quality indicators as appropriate (e.g. Anoxic Factor, Hypoxic Factor, Schmidt Stability, TSI).
3) Identify questions that will direct research needs.

4) Better identify, educate and inform direct and indirect stakeholders to build support base for protection and restoration of Maine lakes.
5) Develop physical and social science-based public policy and encourage behavior change in order to implement the initiatives needed to sustain lake resources and services.

From these elements, three teams have been established. The *Goals* provide the overarching principles that guide decision making for the group. *Objectives*, specific measurable steps, are included for each *Goal*; placeholder notes are included and may be incorporated into existing objectives or be fleshed out into their own objectives. Note that these have yet to be prioritized in terms of ability to implement, cost-effectiveness or usefulness.

LAKE SCIENCE TEAM

GOALS: To expand lake and watershed monitoring and assessment to include all factors critical to successfully manage for resilience; to define individual lake vulnerability in order to better evaluate trophic status and trends and predict each lake's tipping point - the point at which each lake reaches a point of rapid and potentially irreversible decline in water quality.

1. Expand basic monitoring

a. Establish three or more regional support hubs (LEA, MC, BRCA, VLMP) to provide assistance for lake monitoring. Each hub must have adequate space for the processing of samples prior to submission to a lab. Ideally, there would be staff on site from May through October to assist with processing tasks; the actual amount of time required each week might be 8-12 hours (total of 26-39 days).
b. Equip three or more regional support hubs with appropriate equipment and materials to obtain and filter chlorophyll samples, refrigerate samples, perform basic chemistry (pH meter, fluorometer, color wheel or spectrophotometer, conductivity meter, and apparatus to do alkalinity titrations).
c. Establish hub-specific Quality Assurance Standard Operating Procedures (SOPs) and safety guidelines.
d. Procure support to provide annual certification training of volunteers and staff at hubs by either DEP or VLMP staff (Secchi disc clarity, pH, alkalinity, oxygen, temperature, chlorophyll-a, phosphorus, core sampling, etc.).
e. Procure support for additional data entry and Quality Control evaluations.
f. Prioritize lakes and/or lake groups for on-ramping over a five year period beginning with regional entities like those represented by the Lake Leaders, informal collaborations of regional lake associations, and interested volunteers in the VLMP (~400).
g. Continue promoting collection of phosphorus surface grabs by individual volunteers not collecting epilimnetic core samples. Continue developing chlorophyll filtration kits for use by lone volunteers.
h. Contact state and private labs to express the need for sample analysis within Maine.

2. ***Expand enhanced monitoring***
    a. Increase capacity for larger associations and regional hubs to identify, categorize, and monitor algae and zooplankton populations, including Gloeotrichia and other blue-green algae.
    b. Compile a list of researchers and monitoring groups using continuous monitoring platforms. Establish that all are participating in GLEON. Evaluate geographic distribution of continuous monitoring buoys to identify regions within which 'sentinel lakes' should be chosen. Establish a timeline for procuring support (financial and logistical) for the installation and maintenance of new buoys. Create Quality Assurance SOPs including Data Quality Objectives (DQOs) so that data meets both GLEON and government standards for research and decision making.
    c. Evaluate use of sonde and benchtop fluorometers for monitoring algal pigments. Determine how to best utilize this technology in the future, including possible replacement of traditional chlorophyll testing, determination of spatial distribution of algae in lakes, calculation of ratios of chlorophyll to phycocyanin to evaluate risks posed from cyanobacteria (formerly known as blue-green algae).
    d. Enhance existing monitoring for cyanobacteria using EPA phone apps (Bloomwatch, Cyanoscope and Cyanomon). Continue setting up ability for the cyanotoxin microcystin to be measured in frozen lake samples at DEP (note: have purchased one of two instruments already). Establish collection and sample submission SOPs for monitors to use.
    e. Expand sediment monitoring of sediments for Fe/Al/P speciation to determine ratios of elements critical for evaluating susceptibility of each lake to internal recycling. Prioritize lakes by size and depth. Establish transferable SOPs to enable other institutions of higher learning and private labs to conduct this modified Psenner analysis. Establish Quality Control evaluations to validate results.
    f. Increase the use of inexpensive temperature monitoring chains in lakes (HOBO sensors) to document stratification patterns and the effects of climate variability in lakes for which this need exists and in sentinel lakes. Identify all lakes currently deploying temperature chains. Establish a common data repository for data. Establish SOPs for the use and deployment of such chains. Determine criteria for targeting new lakes for deployment of chains (e.g., sentinel lakes, lakes with internal recycling questions), to establish circulation patterns by size, depth and geographic orientation with respect to wind events.
    g. Evaluate the usefulness of measuring turbidity (Hach kits and phone app) and potential for using Landsat data (available for most of the past 30 years) to look at historical trends and turbidity.
3. ***Expand use of data analytics; inventory and improve accuracy of morphometric and watershed variables used in modeling lake processes***
    a. Apply Anoxic Factor or Hypoxic Factor calculations to existing dissolved oxygen data. Increase reliability by refining calculations, increasing late-season dissolved oxygen data collection and building accuracy assessments into the formula. Determine which lake types for which these should be calculated and which lake types may produce erroneous results due to inherent morphometric features.

b. Apply Schmidt stability calculations (metric that evaluates the strength of stratification) to temperature data. Determine lake types for which these calculations are valuable and which lake types may produce erroneous results due to inherent morphometric features. Incorporate reliable stability component into statewide lake vulnerability assessment.
c. Update flushing rates using current precipitation data.
d. Evaluate usefulness of higher resolution bathymetry in model development (may require testing of a few lakes). If needed, promote collection of higher resolution data along with lake elevation and appropriate metadata.
e. Inventory GIS coverages [land use, soils, surficial geology, bedrock geology, and associated variables (erodibility, etc.)] owned by state, federal and other entities (TNC, UM, Sewell) and catalogue data by resolution, age and content to facilitate access to best spatial data for model development. Identify needs for spatial data coverages and means to acquire (e.g., septic systems determined from town data).
f. Assess current data compilation, analyses, and reporting methods. Evaluate alternatives particularly using an informatics approach aimed at collapsing data and conveying meaning.

4. Review and evaluate recent research to determine transferability to or expansion in Maine

a. Thoroughly review recent studies that link water quality to littoral (near-shore) and riparian (shoreline) condition (EPA; Merrill & Deeds' "The Effect of Lakeshore Development on Littoral Habitat"; Rick Van de Poll – Squam Lake, others). Track progress of DEP's method development for evaluating and littoral and riparian habitat and function (vegetation, macroinvertebrates, habitat, human disturbance). Test DEP method, when finalized, on LakeSmart and other lakes.
b. Review case studies and evaluate in-lake remediation effectiveness, options, methods, needs and costs.
c. Conduct resilience and climate change risk assessment and review and inventory stormwater infrastructure needs.
d. Review the status of invasive aquatic plant infestations, control techniques, prevention initiatives and estimate present and future funding needs. The State's model for addressing this threat may be helpful for defining water quality protection efforts.

5. Identify and address research needs (need to add to this list and thoroughly vet)

a. Continue research into sediment geochemical processes and pathways. Develop a series of questions to guide the next 5 years of research in Maine lakes.
b. Evaluate benefits of routine CO_2 monitoring to better characterize respiration rates in lakes to better understand trophic state. Determine which lakes could benefit from this information. Develop a series of questions to guide research over the next 5 years.
c. Continue with research to enhance the Lake Vulnerability Index to better assess the level of water quality risk for each lake and to evaluate trends. This Index will include relevant hydrologic factors, watershed characteristics/land use, susceptibility to the effects of climate change, and social attributes (lake community engagement and stewardship).

COMMUNICATION, EDUCATION, ECONOMIC AND SOCIAL SCIENCE TEAM

GOAL: To create a communication strategy that utilizes scientific and economic information to educate Maine property owners and visitors about water quality and to motivate them to support science-based policy and behavior change.

1. ***Identify all stakeholders for the purpose of effectively expanding educational outreach***
    a. Generate a list of stakeholders [residents, landowners, visitors, civic groups, schools (especially through experiential and outdoor learning and field trips), outdoor sport and environmental groups (e.g., SAM, Maine Guides, TU), state agencies (IF&W), state and local policy makers, lake associations, realtors, marinas, campgrounds and summer camps].
    b. Determine contacts for each stakeholder group and the best means of communicating with them utilizing social science models to promote stakeholder education and engagement.
    c. Build organizational and community capacity and support for lake protection through local and regional lake organizations.
2. ***Examine social equity issues related to water resource policy, access and use to identify underserved populations and barriers to change.***
    a. Native peoples
    b. Citizen populations
    c. New citizens
3. ***Update and expand upon studies aimed at establishing clear economic links to lake resources including the economic benefits of lands in forestry and conservation*** (Boyle/Bouchard/Scheutz study "The Effects of Water Clarity on Economic Values and the Economic Impacts of Recreation Uses of Maine's Great Ponds").
4. ***Share and strengthen watershed education initiatives.***

POLICY AND BEHAVIOR CHANGE TEAM

GOAL: Develop science-based public policy and encourage behavior change in order to implement the initiatives needed to sustain lake resources and services.

1. ***Thoroughly review existing laws and standards to determine effectiveness; update as dictated by lake science.***
    a) Develop a list of standards to review and legal references.
    b) Develop a list of contacts within each state agency tasked with implementing each standard.
    c) Review and prioritize standards for revision.
        i) Shoreline Zoning Act and town SLZ ordinances
            (1) Make shoreland zoning watershed-based instead of town-wide so standards can be tailored to each water body.
            (2) Require and utilize Code Enforcement Officer/landowner acknowledgment forms to assure that those conducting construction projects know the standards that apply.
            (3) Require lake shoreline photo inventories and pre-construction photos with permit applications to document conditions.

(4) Assess grandfathered land uses to determine which are most harmful to water quality and consider ways to address them.
(5) Provide town Code Enforcement Officer sign-off on DEP Natural Resources Protection Act (NRPA) permits in the shoreland zone to avoid miscommunication related to split jurisdiction with NRPA and shoreland zoning.
(6) Include a natural hydrology standard (see 2a below).
(7) Promote use of simple, passive, low maintenance Best Management Practices (BMPs).

ii) Site Location of Development Law, Town Site Ordinances, and Plan Reviews
(1) Require mandatory third party review for construction of engineered BMPs, proper oversight of construction/implementation, and long-term BMP monitoring and maintenance to assure projects function according to intent and minimize phosphorus export from the site; this will assure that plans approved years before construction are effectively implemented.
(2) Revise storm event assumptions to assure proper stormwater system sizing and construction.
(3) Include a natural hydrology standard (see 2a below).
(4) Promote use of simple, passive, low maintenance BMPs.

iii) Stormwater Management Law
(1) Include a natural hydrology standard (see 2a below).
(2) Promote use of simple, passive, low maintenance BMPs.

iv) Review Tree Growth and Open Space classifications to provide maximum incentives for sustainable forestry and conservation land.

v) Placeholder for standards used in forestry, agriculture, by DOT, etc.

d) Propose updates to appropriate regulating entity, NRCS and appropriate legislative bodies.

2. Identify needs and gaps in existing standards; draft standards to fill gaps.

a) Enact a Natural Hydrology Standard. Stormwater management in lake watersheds needs a two-pronged approach. Phosphorus export must be controlled on each lot with the use of (1) simple, passive, low-maintenance BMPs (in order of priority: buffers, level spreader, appropriate sized/constructed rain gardens - lest they become wetlands), and (2) by maintaining natural hydrology of multiple intermittent and low-order streams to avoid secondary phosphorus sources due to channelization of flow along roadways and resultant downstream erosion from increased flows.

3. Review intent and effectiveness of BMPs; review cutting-edge BMPs; identify simple, passive, low maintenance BMPs as preferred controls.

a) Prioritize BMPs for effectiveness in use for specific situations.
b) Require that BMP filters have appropriate media to maximize effectiveness.

4. Draft model ordinances and policy change language for legislative action.

5. ***Develop a local and state governmental outreach plan***.

6. Promote behavior change.

a. Expand LakeSmart and YCC Programs.
b. Develop a PR campaign and media packages, including science translation materials.

Acronyms/abbreviations for Actual and Potential Partners

30Mi – 30 Mile River Watershed Association

AWD – Auburn Water District

BRCA – Belgrade Regional Conservation Alliance

CWD - Cobbossee Watershed District

CS - Citizen Scientists

DEP – Maine Department of Environmental Protection

DOT – Maine Department of Transportation

EPA – Environmental Protection Agency

FCW – Friends of the Cobbossee Watershed

GLEON – Global Lake Ecological Observatory Network

IF&W – Maine Department of Inland Fisheries and Wildlife

LEA – Lakes Environmental Association

LL – Maine Lake Leaders (regional lake association executive directors and staff)

MC – Midcoast Conservancy

MEEA – Maine Environmental Education Association

MEMA – Maine Emergency Management Agency

MFS – Maine Forest Service

MLS – Maine Lakes Society

MLSC – Maine Lake Science Center

MLRC – Maine Lakes Resource Center

MLTN – Maine Land Trust Network (Warren Whitney)

MMA – Maine Municipal Association

MEGIS – Maine Office of Geographic Information Systems

NRCM - Natural Resources Council of Maine

PWD – Portland Water District

SAM – Sportsmen's Alliance of Maine

Tahoe – University of California at Davis Tahoe Environmental Research Center

TNC – The Nature Conservancy

TU – Trout Unlimited

UM – University of Maine, Orono

UMF – University of Maine, Farmington

UNE – University of New England

UNH – University of New Hampshire Stormwater Center

USM – University of Southern Maine

YCC – Youth Conservation Corps

VLMP – Volunteer Lake Monitoring Program