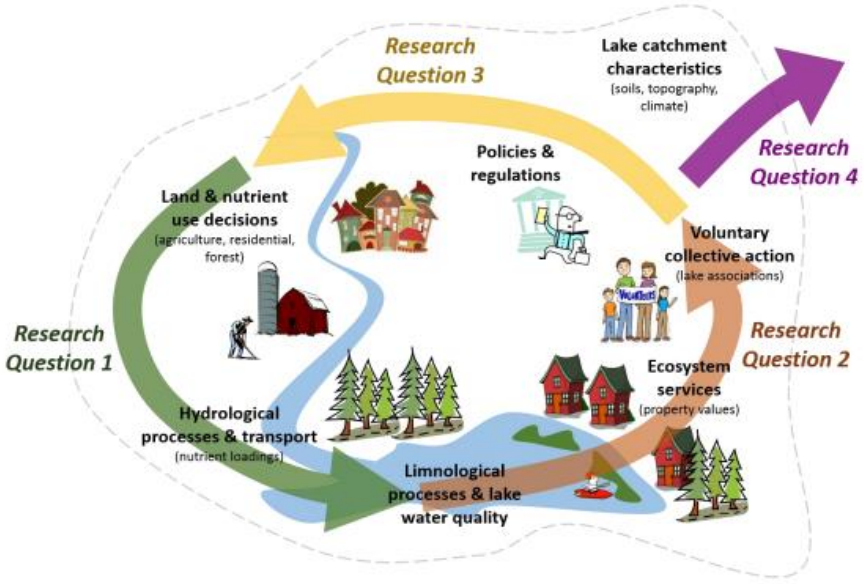
Day 1: Madison CNH Workshop

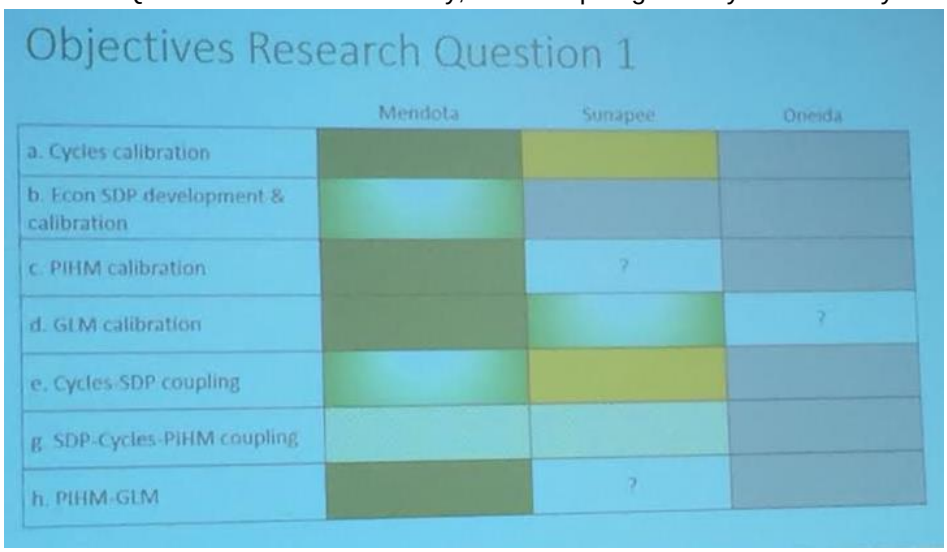
31 May 2017

Kelly: Overall project update

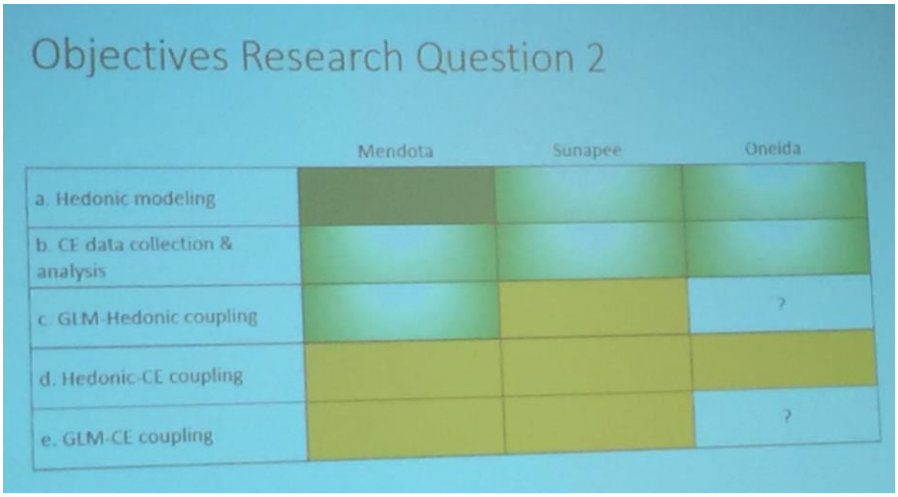
- Project objectives
    - 4 intellectual merit research questions



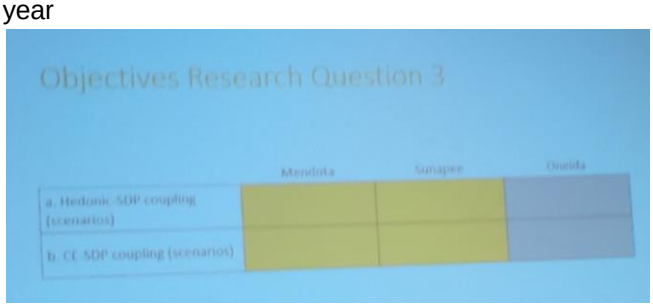
    - Broader impacts: (1) lake association connections, (2) interdisciplinary graduate training
- Where we are (climbing the mountain): Halfway into the project
    - Research Q1: Mendota well on its way, but Sunapee generally not started yet



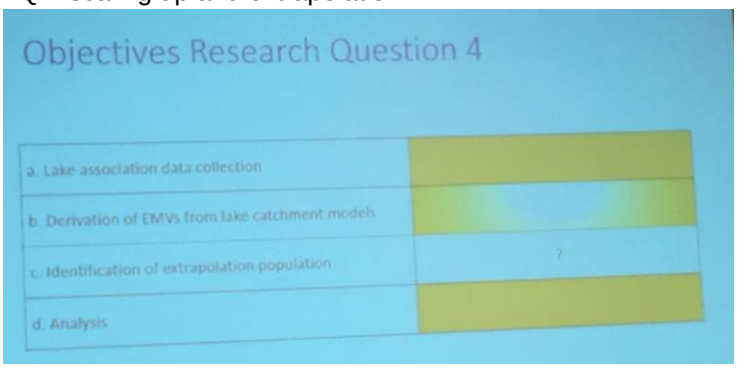
        - Oneida has unfortunately been reduced due to lack of expertise on the lake (hopefully still have GLM/hedonic components)
        - Working on model coupling
    - Research Q2:
        - CE = citizen engagement
        - Some coupling outputs, but generally were slated for Year 2, 3



- Research Q3:
    - ***What scenarios do we want to look at?*** This is a key conversation to have as a group this year



- Research Q4: scaling up and extrapolation

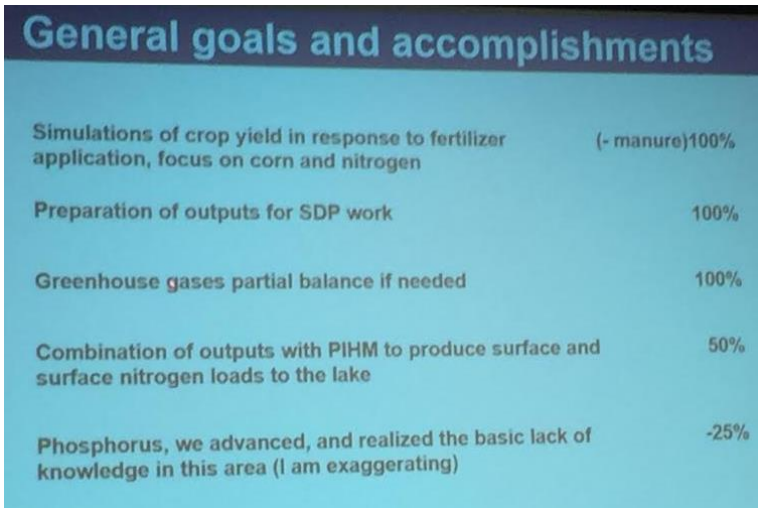


- Broader impacts: have established lake association contacts, began contacts with them
    - ***Key question: how to disseminate results beyond academia***
    - Outpacing plan in student involvement (8 grad students, 3 undergrads interns, 4 postdocs to date)
    - Seeking project manager at VT to help with administration/research
- Where we're going: Year 3 workshop Fall 2018 in Sunapee
    - Getting papers out the door! → working in teams and subteams

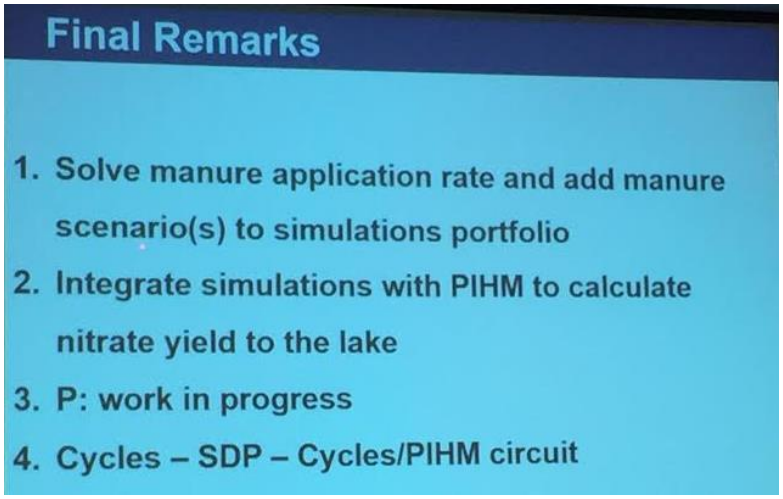
Team Updates: What are different models doing at this point in the project?

Armen: Cycles/Biome BGC

- Ag simulations for Mendota



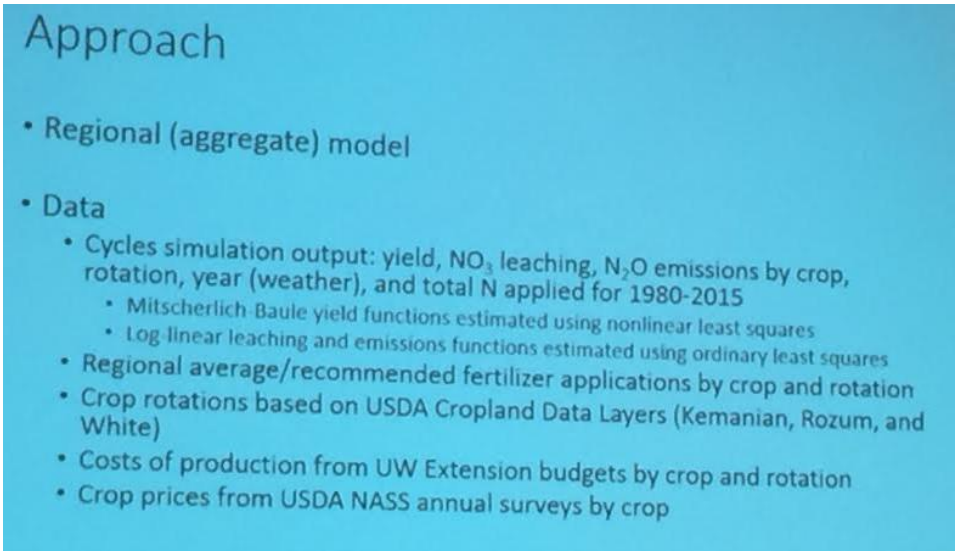
- Simulated rotations of crop in the landscape
    - 40% corn; 10% soybean; 15% alfalfa; 35% other → about 25% of total is consistently corn
    - Currently not possible to do this together with PIMH
- What is optimal management for nutrients in water quality → how to do this in a continuous crop like corn?
    - Soil files and response curves
- Infrastructure now roughly in place to do this model for other watersheds
- Opportunistic evaluation of Cycles (Arlington, WI continuous corn experiment in 3 background N management levels)
    - Soil organic carbon very well simulated with no calibration (R^2 0.62 - 0.72; slopes very close to 1)
    - Model also does well of predicting nitrogen removed at harvest, but quite a bit of dispersion (but not bias)
- Simulated grain yield response curves (polynomial responses)
    - E.g., corn after corn: optimum return between 150 - 200 kg/ha but varies by year
    - Corn after alfalfa interesting responses over time lag
- Cycles can inform when nitrate leaching occurs; PIHM estimates role of groundwater nitrate into river
- Nitrous oxide emissions are overwhelming carbon storage (also money that is put on the land, going into the air)
    - ***Look at tradeoffs between greenhouse gas emissions and farmer profits***
    - Losses accumulate quickly as application rate increases
- Map depth to groundwater for each triangle in the watershed
    - Headwaters are concentrated areas of groundwater activity, major contributions to flow
    - Triangles that are moving the most water → what to do with the output?
    - Run coupled PIHM and Cycles for one management strategy to highlight critical areas
- Phosphorus: coupled only loosely with C, N
    - Working on different ways to fractionate P (not clear cut), tie it into model



- Doesn't really rain a lot in WI; may have 3-4 months of no surface leaching after spring pulse → lot of time for denitrification, and N entering river is through groundwater
- Nitrogen is a manageable problem if we can take care of the manure; a lot less optimistic about phosphorus (especially for no-till)
- Average N application is 1 pound per bushel of yield (~180 kg/ha; 120 harvested; 60 kg/ha at play for storage or leaching)
    - ***If cover crop looks crappy, you should be happy*** (not much nutrient available for them to pick up)

Kelly: Economic SDP

- Building on output from Cycles simulations
- Currently just a Programming model; stochasticity and dynamism to be added
- *Nonlinear constrained optimization problem*: land and fertilizer decisions to maximize profit while land allocation is constraining resource
    - Simple annual problem, not dynamic
    - Currently using watershed-scale, aggregate model (could use field-scale model)
        - Single optimization for the watershed, proportion of land in each crop rotation, static annual decisions for crop, calibration with standard calibration technique: Positive Mathematical Programming (key benefit of this approach)
        - Assumes that producers are risk-averse… but they likely aren't
            - Can account for unincorporated factors that affect producer choice
    - ***Is watershed aggregate appropriate or need to move to more-difficult-to-calibrate field-scale model?***



- PMP calibration: addresses tendency toward corner solutions (putting all crops in just corn, but which we don't actually observe in the field) by capturing unobserved factors that affect decision-making
    - Calibrating on land allocations by rotation
- Current run just for year 2003: estimating yields per crop
- **1 lb/acre ~= 1.12 kg/ha** units dependent on target audience
- One scenario with change in total N applications: 30% N reduction but with no adjustment in land allocation
    - All available N is shifted into continuous corn (greatest benefit per unit N applied)
    - Reduction in corn, no change in soy or alfalfa
    - 50% reduction in N application; proportional reduction in leaching not as large (~25%) due to focus on continuous corn
    - Profit and emissions also decline
- A lot of work left to do for scenarios; need to calibrate function for land allocation
- ***Are producers applying based on extension recommendations (or what fertilizer company recommends)?***
- ***How would model outputs change based on whether precipitation is drought vs. wet year?***
- Timeline of people making decisions is very different than the biological/hydrological timescale (e.g., annual vs. hourly/daily)
- Need to be very transparent about how model compares to reality of applications
    - Importance of manure to yield, leaching problems of P with no-till in scenarios (soluble P with surface runoff), overestimating utility of buffer strips, etc.
        - What information do we have about manure application? Can estimate average per county

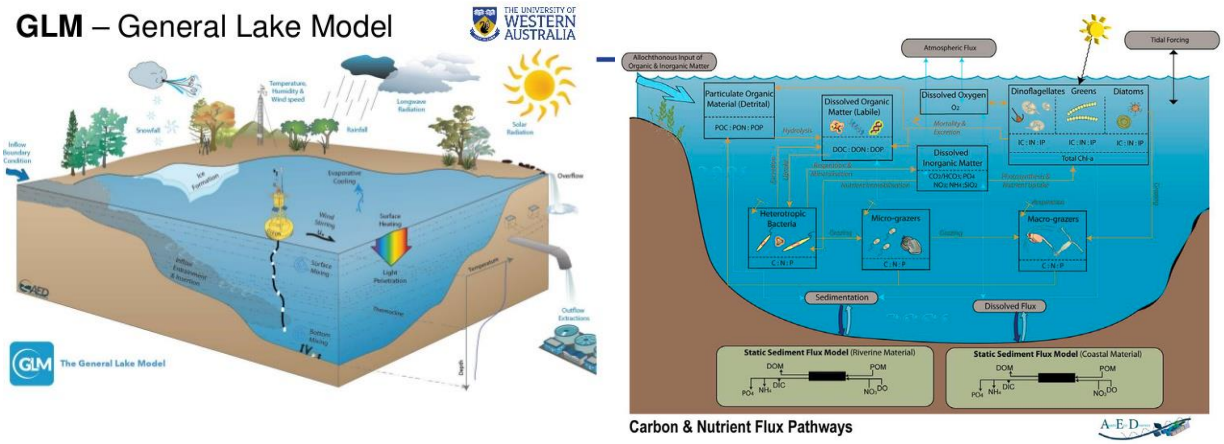
Chris and Yu: PIHM

- Collaboration tools: ODS and shareable document with details of catchment and lake to visualize and share data
- Understanding residence time of nutrients in catchment and lakes
- Hydrological processes drive lake-catchment nutrient and sediment transport
    - Time series change of hydrological connectivity (vertical and horizontal)
- PIHM: surface, groundwater changes (storage, flows) coupled to GLM (PIHM-GLM)
- PIHM-GLM: exchange of information between PIHM and 1-D GLM (sequential or fully coupled)
    - Implicit/explicit solver options for model output
    - Inputs: lake geometry and bathymetry, attributes (precip type, soil beneath lake)

    - Data exchange between lake and catchment: bank elements at each time step
    - Incorporating weir management of lakes (broad-crested weir + orifice flow)
- Use of lakeFlux variable to feed into GLM
    - Stream inflows for each stream; overland & groundwater inflow/outflow; stream outflow
- Gate information to predict orifice flow rate over time (regress gate height ~ lake water depth)
- Calibration of inflows (4 inflows for Mendota); working to improve outflow model (in winter)
    - Stream contributes ~80-90% of inflow (at end of lake; though upstream this is from groundwater); very little direct contribution from groundwater to lake
        - Little year to year variability in each inflow's proportional contribution to annual inflow (in Mendota); proportional contribution changes year to year in Sunapee
    - Net groundwater tends to be positive (moving into lake); except in very dry year, moving from lake to catchment
- Ongoing work: better calibrate Mendota, run long-term simulation (1979 - present); calibration & validation of NTL lakes and Sunapee
- ***Sunapee GLM currently simulating 11 inflows, rather than 6 → decide whether/how to further divide watershed for PIHM***
    - Already incorporated as surface flow in PIHM (may already be captured by DEM approach to identify the streams)
    - Provide Yu the coordinates of the 11 stream outlets

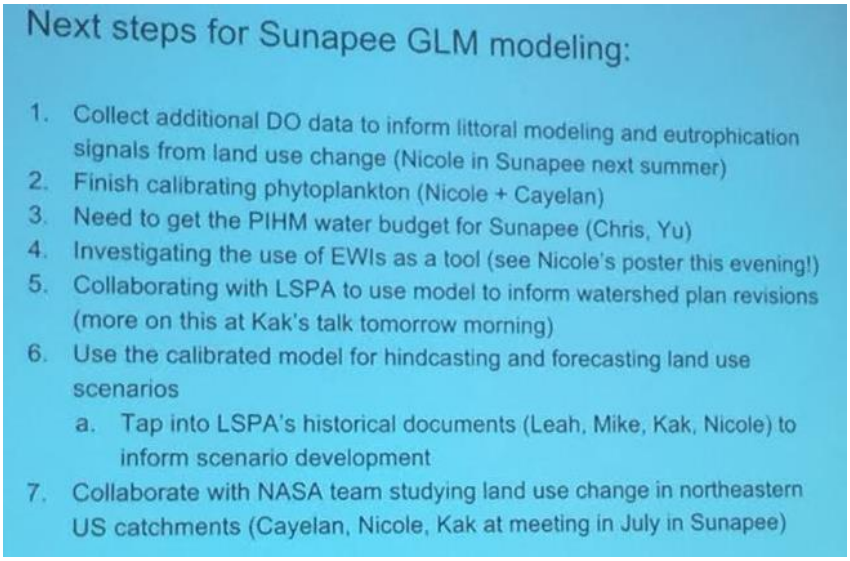
Cayelan and Paul: GLM

- Busy year (about one milestone per month!); includes engaging with LSPA, PIHM team, GLM-AED calibration progress
- GLM and AED couple lake physics (1 dimensional) and chemistry/water quality (carbon, nutrients, phyto- and zooplankton modules): ~500 parameters to fine-tune in calibrations

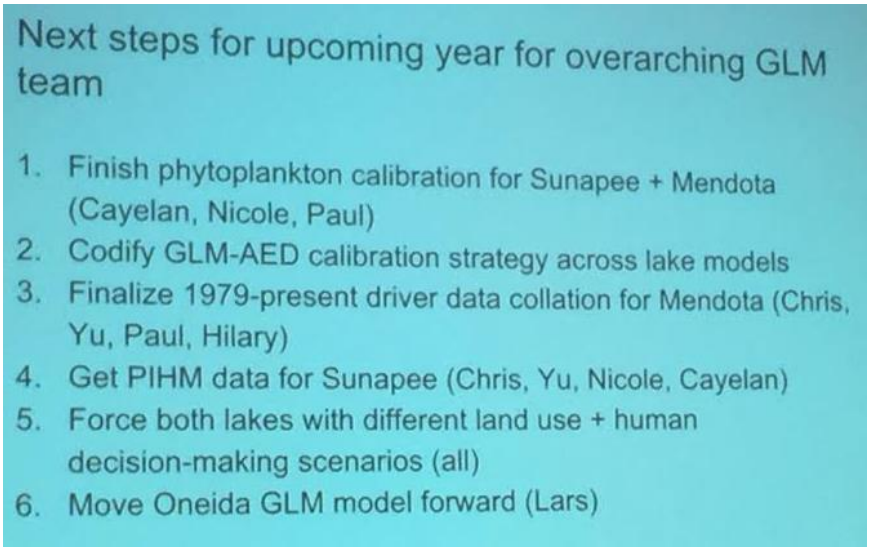


- Phytoplankton as a key response variable for landowner perception
- **Mendota GLM modeling**: PIHM from 2000-2014, limited data for inflow solute concentrations (N and P)
    - ***How do you accurately model loads into Mendota when observational data is missing?***
    - USDS rLOADEST package (model 7: Q, time as inputs; N or P as output) and PIHM inputs
    - 3 key outputs: water clarity (via organic carbon), phytoplankton biomass, dissolved oxygen
        - Julia Hart's MS thesis: organic carbon cycling and greenhouse gas fluxes (Mendota consistent source of GHG to atmosphere)
    - Doing a good job modeling temperature; oxygen dynamics (anoxia important in hypolimnion; hard to model threshold between anoxia and not); Secchi depth (long-term goal is to increase Secchi depth in summertime; e.g., reduce peak in summer OC)

    - If N or P doubled or halved: organic carbon peaks in summertime in calibrated carbon → scenarios don't change it much!
        - Long-term legacy (internal loading) preventing response to reductions in external loads
        - In reality, reduced internal loading would require decadal-scale changes → 50 year lag time in water clarity with consistent reduction in nutrient loading
        - When you halve N, N-fixing cyanobacteria (bad!) increase
    - ***What are the seasonal dynamics of external (dominant in spring) vs. internal nutrient loads?***
        - If we want to see effects of human decisions in the watershed, we'll have to run these models for decades!!
- **Sunapee GLM modeling**: See Nicole's poster tonight!
    - Sunapee observational data very different from Mendota: no confidence in measured discharge, but feel good about nutrient data
    - Landuse changes over time (Landsat) in subcatchments, seeking early warning indicators for management purposes
        - Making realistic scenarios based on potential future land-use change
    - Some subwatersheds have changes in annual phosphorus inflows (but keep in mind this is all much lower than in Mendota!).
    - Successfully modeling temperature and dissolved oxygen profiles year-to-year (30 years!)
    - ***Linking model output from different spatial and temporal resolution are a key effort!***



- **Oneida GLM modeling**: see Lars' new book "Oneida lake: long-term dynamics of a managed ecosystem and its fishery"
    - Increased temperature increases stratification of Oneida: polymictic lake becomes monomictic! (Hetherington et al. 2015)
    - Already seeing change in P dynamics due to increased stratification
    - Also seeing effects of waves of invasive species (zebra mussel, quagga mussel, now gobies)
- **Overall GLM findings and next steps**



- Mendota/Sunapee ripe for comparisons
    - Forested vs. urban a huge contributor to baseline contrasts in these lakes, topography differences also important
    - What is the equivalent area of green grass (suburban) to agriculture in terms of nutrient input potential (e.g., is 1 acre of lawn ~= 5 acres of agriculture)

Kevin and Weizhe: Hedonic modeling

- Close to interim paper for Lake Mendota quality effects on property values
- Selected and cleaned data from National Ass'n of Realtors for communities on Mendota lakeshore; obtained and cleaned additional property sales data; merged with census, community, & water quality data
- 1st phase hedonic model for Mendota: home price is function of water quality, other characteristics; how do these change?
    - Can be marginal approximation of value but need to be careful not to over/under predict changes beyond the local scale
    - 2nd stage will allow for larger-scale changes (scaling up to LAGOs)
- Policy management would require welfare management model (what is the benefit to the greater public?)
- Focusing on 3 observed water quality variables: Secchi, total P, chlorophyll as mean summer values
    - Modeled data will provide more complete set to fuel hedonic model
- Trying to predict the coefficients rather than overall model prediction (problems with multicollinearity, bias)
    - Quasi-experimental designs via repeat sales; but few of these available!
- meanSecchi and meanTP: many other studies have looked at worst conditions rather than mean
    - Previous studies also focused on lakefront and 1-row-back sales; but we're looking at larger community
- Time dummy to control for effect of recession during time series; control other factors via census data, structural and location data
- ***How to control for proximity of other lakes (e.g., in Madison)?***
    - Factored in separately; hyper-correlation if also directly including distance from Monona
- ~20,000 property sales in Madison communities near Mendota (~200 for waterfront)
- Data is closing date; decision made (on average) 90 days prior
    - Don't know how long they searched; moving from out of town or within Madison; information used to inform the purchasing decision

    - Some communities lacking data
- House prices increased with Secchi depth; decrease with TP; strong increase if waterfront property
    - Non-sig. Interaction between Secchi and distance but retained in model
    - +$12,000 waterfront price (5%) premium for 1m increase in average Secchi; ~$2,000 (1%) for mean TP change of 0.01 mg/L
    - Secchi increases from 2.67 to 4m; TP decreases from 0.11 to 0.03 mg/L (or 0.3 to 0.11 decrease? Typo on slide…): $33,000 increase (14%) on lakefront
- Predict out instantaneous change in value: capitalized change in value going forward
    - ***How to adjust for change through time as water quality changes?***
    - How to extrapolate over the community? Consider changes in property tax revenues? Other considerations Mike will uncover?
    - Challenges for Sunapee: small, few sales
    - Oneida: more data available, good thing!

Mike Sorice: Civic engagement

- Getting ramped up! 2016 was quest for data → institutional data in people's' heads, basements, and file cabinets
- Role of civic (lake) associations in improving communities (sometimes with policy authority)
- **Organizational capacity:** what about the institution facilitates success? Personality of the group, funding and revenue, guiding documents
- Engagement: is group connected to each other? Leadership and organizational psychology
- **Effectiveness:** factor of organizational capacity and engagement. Are you producing an effect that is wanted and/or intended? Policy influence, social trust, embeddedness with state agencies, partnerships
- Education and outreach via survey research
- Water quality and political engagement both change over time → What types of information can be tracked?
    - How often is group talking about ecosystem based management over time? Is lake association being mentioned after bloom events?
- ***Role of social media data?*** May be possible for much more recent time period
- Where is the institutional knowledge? Dataquest 2016!
    - Oneida Lake Association (since 1945): strong fisheries focus transitioning to environmental partnership
        - Interviews, stories, etc.
        - How to move beyond impression as “the walleye club”?
    - Mendota: Clean Lakes Alliance
        - “What lake association?” big disconnect between academics and civic groups?
        - Young organization; hard to detect effectiveness in this group to date
        - Backed by funding so unique from Oneida group → **boundary organization**
    - Lake Sunapee Protective Association (since 1898): preserve and enhance lake region
        - Historically, education has been much of the emphasis
        - Mysterious data vault? Supposed to be good records
- Next summer big data collection push!
- ***How do we define lake association? Civic association? How much does the model matter?***
    - CLA: “We are not a lake association”

Afternoon working group sessions

Instructions

- Designate a note-taker
- Identify primary research question
- Determine what you need to answer the question
- Put together a plan and timeline for the project
- Identify who else needs to be involved who is not in the group
- Share an informal report-back today and slides tomorrow
- Get the project plans into ODS
- Designate leads for papers/products

Reporting out

GROUP 1: ***Can changes in agricultural land-management practices affect water quality? If we do all BMPs will it really change water quality to an acceptable level?***

- Cost of reducing N to improve water quality – supply curve for N reductions
- What is the minimum payment required to compensate farmers to reduce N?
- Can that minimum be recovered from beneficiaries in the watershed?
- Groundwater N pollution is an issue for Mendota watershed (changes in N loading will not affect lake water quality); consider residence time (how much time to flush the contaminated water out), determine these using PIHM hydrodynamic model
- N-reducing practices
    - N fertilizer reductions
    - Cover crops
    - Buffer strips
- Questions/plan
    - LEAD: Kelly Cobourn
    - What is the minimum cost, in terms of lost profit, of improving surface water and groundwater quality by reducing N leaching from agriculture?
    - Tasks
        - Determine initial conditions/current production practices – arrange meetings with Kucharik, Booth and/or NRCS while here
        - Determine set of BMPs to consider as a means of reducing N
        - Determine representative producer types within the catchment (spatial arrangement of producers determines the potential water quality effects of N reductions at each site)
        - Simulate
            - Production effects of each BMP
            - Cost of implementing each BMP
            - Water quality improvement from each BMP (as a function of N applications/leaching/etc)
                - Lake water quality improvement
                - Groundwater quality status
                    - Lake, streams
                    - Drinking water
                - Steady state residence times in the aquifer from PIHM
                - Time in path length from site to surface waterways
    - Personnel
        - Lele Shu on Cycles simulations
        - Weizhe Weng on optimization models
    - Subsequent paper(s)
        - Extend this framework to consider P, link supply of P reductions with value of improvements in lake water quality

GROUP 2: ***Questions are not actionable, can we build things into BI process to get to the questions? Yes, but don't know what that is yet.***

- How can we have impacts now, before we have data and results? LakeLines journal (NALMS): how do you link science and lake association impacts? How do you make it translatable?
- Proposed title for paper 1: “Lake associations as boundary organizations”
- Lead and timeline TBD
- Subsequent paper: Case study paper on LSPA’s work that builds on Nicole’s work

GROUP 3: ***Based on lake characteristics defined by LAGOS, how does water quality respond to perturbation? Variability in cross-section, but not in time series in LAGOS. GLM tends to focus on one lake and time series variation.***

- Use LAGOS to identify ecosystem gradients
- Statistical analysis to identify ecosystem gradients that are interesting to look at (Joe)
- Set up GLM Monte Carlo simulations that span the gradient based on LAGOS (e.g., % ag in watershed); examine how perturbation affects the relationship between that gradient and lake water quality outcomes
- Lead and timeline TBD

GROUP 4: ***6 papers related to property values and lake water quality***

- Reducing nutrient loading to increase property values and tax revenues for Mendota”
    - Lead: Kevin
    - Co-lead for scenarios: Cayelan
    - Summer 2017
- Weizhe’s dissertation chapter
    - Lead: Weizhe
    - Summer/fall 2017
- “Direct and indirect water quality drivers of property values”
    - Predict secchi with other variables, then secchi effect on property values
    - Leads: Kevin and Cayelan
    - 2018
- Comparison of EMVs across catchments
    - 2018
- Modeled vs. observed variables in hedonic model
    - 2018
- Are homebuyers forward looking when considering environmental characteristics to predict out what water quality might be in the future, i.e. what their investment looks like when they buy?
    - Risky research question
    - 2019

Day 2: Madison CNH Workshop

1 June 2017

Chris Duffy: Data resources in Mathematica

- Computable document that can be used to produce reports for individual lakes or across lakes
- Allows you to reach into databases that are hidden behind the images and preexisting code in the document
- Also links to relevant Wiki pages, for example
- Chris will send out link to site and to history document

Pat Soranno: Manuscript leadership styles

- How do you announce manuscripts? Need a process
- Guiding principles for manuscript development
    - Transparency
    - Inclusion and fairness
    - Protection and promotion
    - Accountability
    - Efficiency and productivity
    - Creativity
- Manuscript management strategies
    - The Han Solo strategy – single lead
    - The Batman & Robin – dual leads
    - The High School Clique – small, core group leads; moves more toward tapping into group creativity
    - The 7 Dwarves – rarest; everyone is present for all aspects of manuscript development; more than 7 is really hard; obvious risk is loss in efficiency and productivity
    - Organized Chaos – break moving pieces into individual assignments and lead coordinates individual pieces; people work more in isolation to build up a larger effort in pieces
- Skills needed for manuscript management
    - Facilitation
    - Time management
    - Conflict resolution
    - Leadership
- Dissertations
    - Include preface with list of manuscripts coauthored in project; describe how the student is the intellectual lead of the dissertation chapters
    - Han Solo approach might make sense for a dissertation
    - Can be collaborative, but student needs to demonstrate leadership
- Project authorship policy needs to account for differences in working styles, some people are organized, some are more creative/bigger picture thinkers
    - Leadership style and facilitation needs to take into account different strengths and bring them to bear
    - Optimizing individual vs. group creativity
- What kinds of conflicts arise? Top 3
    - Authorship lists being too large such that non-contributors are included
    - Power dynamic, early career authors need to get credit for their effort
    - Transparent communication, individual coauthors do their own thing without communicating back to group or soliciting broader input into important decisions
- Manuscript types
    - Disciplinary research
    - Graduate student dissertation
    - Interdisciplinary research

- Essay, conceptual, commentary
- Data or methods

All: Scenarios

- Create google sheet with scenario descriptions, goal/objective of scenario, contribution of each modeling component

Kathie Weathers: Lake Associations

- LSPA engagement to date
  - Mike scoping visits
  - CC and NW update on CNH and GLM
    - The Beacon headline – “CNH comes to Sunapee”
    - Bethel Steele data analysis
  - Leah in residence mid-July to early August
  - Team meetings in Sunapee (CNH & NASA)
  - KW mini sabbatical with LSPA to co-develop outreach materials
- LSPA wants a visualization tool to see how humans affect the lake
- Scenarios from full build-out model
  - Predicts increase in P loads into lake
  - Load expected to shift lake from oligotrophic to mesotrophic status
  - How did they use this information? Report distributed to towns, but unsure whether they used the information to develop regulations
- LSPA influence
  - Meets with town managers monthly
  - Poised to reach out to realtors: hedonic model results will be helpful
- Cyanobacterial blooms and ALS controversial correlation: this question comes up sometimes with homebuyers

Adam Sodersten: Clean Lakes Alliance

- Background
  - Founded 2010, originated from waterski festival
  - Objectives
    - Elevate lakes in citizens’ agendas
    - Build community
  - Goal
    - P reduction of 50% by 2025
    - 46,200 lbs of P diverted from the lake by 2025
- Activities
  - Education – Yahara Watershed Academy brings in 25 community leaders/influencers with an interest in water quality, 5-day immersion program (climate change, watershed science, limnology, health impacts, etc), goal is to get commitments to take on a project that they can take back to their organization and undertake with support of academy leaders
  - Volunteerism – engage corporations and sometimes neighborhood groups (15 days/summer on avg)
  - Monitoring – over 70 monitors taking near-shore measurements (end of pier sampling) to capture variability in conditions on the perimeter; upload to lakeforecast.org
  - Citizen action – leaf litter as a major source of P to the lake (?)
  - Fundraising events: goal $500K per year (now $300K)

        - Frozen assets 2017
        - Save our lakes community breakfast
        - Shoreline swim
        - Loop the lake
        - Fore! Lakes
    - Annual report describes what they consider to be “good” water quality
        - Water clarity (feet)
        - P levels (mg/L)
        - Levels determine poor, fair, good, excellent classification (state of WI categories)
    - Legacy sediment removal project
        - Dane County, $12m over 4 years to dredge material out of major tributaries draining to lakes; pilot project undertaken
    - Agricultural community engagement
        - Sister organization Yahara Pride Farms (nonprofit) tests BMPs
        - There are cost-share incentives (county, state, federal) to adopt BMPs
        - Voluntary participation
- Use models to show that they need to take more aggressive action, garner greater resources to recover Lake Mendota

Afternoon working group sessions

GROUP 1: Land management to lake water quality

- To partition landscape, use statistical distribution of hillslopes (average hillslope length); start with average hillslope
- Cycles reflects soil profile of hillslope (on average); generate crop yields, N leaching for set of feasible production practices
    - Determine set of potential BMPs and land management practices
    - Simulate yield and N leaching for each BMP and land management practice and hillslope
- Input yield and N leaching functions into economic programming model; enforce progressively strict N reductions; estimate profit loss associated with various N reductions
- Estimate groundwater quality improvements associated with each level of N reductions (extract residence times from PIHM)
- Other notes
    - Matt Ruark, UW Extension
        - No database on land management practices
            - Talk to land managers and/or surveys
            - Bring Matt into team for professional expertise
        - Armen will write up protocol
            - Manure production poses a challenge
            - Use county statistics and scale to watershed; check numbers with experts
            - Manure is applied in the fall, which is the worst time to apply in terms of leaching (timing of manure applications is one lever we can press to change N leaching)
    - Feasible BMPs
        - Develop a list of rotations and management practices for each rotation
        - Develop a list of BMPs (Armen will develop the list)
            - Cover crops
            - Ryelage as a cover crop and harvest as silage
            - Nitrification inhibitors
            - Etc.
- Timeline
    - Armen and Charlie
        - BMPs (end of June)
        - Rotations and management practices (end of June)

        - Cycles simulations for one producer (end of July)
    - Kelly
        - Preliminary S curve (end of July)
        - S curve for one producer and set of management practices (end of August)
        - Pass optimal practices back to Armen (?)
    - Chris
        - Cycles-PIHM (end of August)
        - Extract residence times from PIHM (end of August)

GROUP 2: Engaging lake associations

- Question 1: Interpreting lake associations as boundary organizations. Why would you want to be a boundary organization?
    - Case study approach
    - Who would it reach?
- Question 2: Visualization of models. How can you use model output with LSPA and other organizations? Can you assess whether and how they use it?
    - Broader impacts workshops can help push this forward
    - Think about measurable BIs, make sure they're useful and effective
    - Transform BIs over the next year to make sure that we get something out of it

GROUP 3: Scaling up and extrapolation

- Question 1: Combining the power of GLM and LAGOS
    - Use LAGOS to generate approximations of GLM inputs. How much do GLM outputs vary as a function of gradients (depth, hydrology, sediment flux)?
    - Lead: Joe
    - Tasks
        - Joe: Define population of lakes
        - Nicole: investigation of GLM
- Question 2: What are the scales of temporal variation in LAGOS lakes?
    - LAGOS coverage is not very comprehensive in the time dimension
    - Use GLM to infill missing observations in LAGOS
    - How much of observed variation is spatial? Are existing data representative?

GROUP 4: Lake to property values

- Question 1: impacts of nutrient loading on property values and property tax revenues: Lake Mendota, WI as a case example
    - Use Mendota GLM 2000-2014 (modeled) as baseline
    - Run scenarios to simulate changes in water quality
    - Lead: Kevin
    - Invitation next Wednesday, June 7
    - Timeline:
        - Data to Weizhe 2013-2015
        - Scenarios sent to hedonic team: lane June/early July
        - Weizhe/Kevin confirm hedonic model results
        - Skeleton draft by end of July
        - Target submission: 15 September 2017
- Question 2: Weizhe's dissertation chapter
    - Focus on different water quality metrics; what emerges as important in hedonic model?
    - Lead: Weizhe
    - Timeline: later this fall before starting
- Question 3: Direct vs. indirect lake water quality variable drivers of property value changes
        - Co-leads: CC & KB
    - Winter 2018
- Question 4: How do attributes of catchments affect response of property values to changes in water quality?
- Question 5: Using observational vs. modeled data in hedonic property models?

- Question 6: Are homebuyers forward looking when considering environmental characteristics of a property?

Day 3: Madison CNH Workshop

2 June 2017

Pat & Joe: Scaling up & extrapolation with LAGOS

- LAGOS – NE and LAGOS – US (new project to scale up to nation)
- LAGOS – NE
    - Data
        - Area, depth for each lake
        - Some field-data of water quality for each lake
        - Identifiers to relate to county, river watershed, region (‘zones’) for each lake
        - Land use, geology, climate for each zone
        - Delineated watersheds
    - Large variation in watershed area
        - Distribution of watershed:lake area ratio across lakes
    - For some lakes, they have TP and Max depth data (N = approx. 5,000 lakes)
    - Most data are 1990-2012
        - Later phase will be to update to 2012-2016
    - 3 modules
        - GEO, LOCUS, LIMNO
        - Resources
            - R package for querying all 39 tables of 3 modules
            - GIS coverages
            - GIS toolboxes
- Many lakes have different structure (% based on number of lakes)
    - Types
        - Isolated: 35%
        - Headwater: 16%
        - Drainage: 32%
        - Drainage with Drainage-Up (has an upstream lake): 17%
    - For isolated lakes, they can have different relationships with groundwater; could potentially identify sub-type based on elevation of the lake relative to the surrounding topography
- Modeling at sub-continental scales
    - Spectrum
        - Data mining models
        - Hybrid DM approach (knowledge based data mining)
        - Empirical, statistical models
        - Simulation modeling with minimal data input
        - Process-based models on each lake watershed CNH systems
    - Potential approaches to scaling from 3 lakes to larger population
        - Semi-intensive: ~100 lakes across extent, some data needed
        - Extensive-nutrients: ~6,000 lakes with nutrient concentrations
        - Extensive-geo: 49,000 lakes with geo-data only
- Identifying the extrapolation population
    - Distribution of lakes in each focal lake’s HUC-4
    - Our focal lakes are large and deep compared to surrounding lakes; ln(catchment/area) ratio close to mean for Mendota and Oneida; Sunapee has a short residence time compared to surrounding lakes?
    - The “most” conservative population (N = 212)
        - Identifiers
            - At least as large as Sunapee (surface area)
            - At least as deep as Mendota (max depth)

        - Has nutrient data (in LAGOS)
    - Features
        - Constitutes a lower bound on morphometry of our 3 study lakes
        - Well distributed across region
        - Biased sample (we have the most information on a small subset of lakes that are large and/or deep)
- Based on land use
    - Mendota: watershed is more intensively in row crops and developed than surrounding area
    - Sunapee: watershed is more forested than surrounding area
- Scaling areas
    - Lake modeling (GLM)
    - Hedonic
    - Others?
        - Lake association identifier (?)
            - Eric's database for Wisconsin
            - NH has an association for associations (NHLA, New Hampshire Lake Association)
            - What would be the objective? Correlation between water quality and lake association presence/absence
                - Loaded question: causality vs. correlation; if we limit our attention to a subset, we might get a spurious correlation in one direction or the other that could lead to erroneous conclusions
                - Snell-Bell work in Maine from 2013 attempts to do this
                - Carleton College in NW Minnesota is looking at a similar question; doing a survey this summer
        - Public vs. private land ownership
        - Census tract level demographic data
        - Ag production data

All: Team discussion of EMVs

- What are they? How can they be used?
- EMVs discussion focuses on data outside of the context of the models and questions
    - Is it for coupling models?
    - Is it for a particular scientific purpose?
    - How can we use and deliver the information?
- Chris, Essential Variables
    - History
        - American Meteorological Association – what are the essential variables you need to build climate models globally
        - NEON – essential biodiversity variables
        - Watershed notion – variables necessary to build a watershed model anywhere (ETVs)
    - Criteria
        - Data is already available on a national or global scale
        - Used within the context of models
    - Goal for this project
        - Goal is to identify those variables useful for anybody developing a CNHS model
        - Match data to processes
        - Marry local scale to national scale
        - Is it identifying variables to understand the system or manage the system?
        - EMV research directions
            - Variables that are useful within a discipline or model for the community of researchers to use
            - Variables to connect components of the CNHS
        - Terminology issue

                - Core coupling variables (CCVs)
                - Issues are embedded within identifying variables passed between models; issues of scale, time, magnitude, etc.
                - Who is the audience?
                    - CNH researchers
                    - Managers (levers in the system), practical/applied target
            - Can the synthesis paper help us?
                - Process of identifying papers for the synthesis
                - Narrow from 594 to 4 papers
                - Highly ad hoc set of studies
            - Dissemination
                - Contact NSF to give a presentation
                - AGU presentation to earth modelers
                - Earth Cube NSF program to link models
- EMV framework paper
    - How can we say it's a "good" way to do it? Do we need results?
    - Capture with a potential title (as a team working paper)
    - Could we use AGU presentation as a catalyst to push this forward?
        - Abstracts due August 2
        - Go for AGU talk/poster or session?
    - Lead: Kelly (at least for now)

All: Closing session

- Target workshop for week prior to Memorial Day
- Objectives for the next year; interests piqued during the course of the conversation
    - Lars: Oneida GLM calibrated and running; water clarity and invasive species (mussels)
    - Joe: Runoff ratio, preliminary tests linking GLM and LAGOS, hedonic model expansion with Weizhe
    - Kelly: SDP model creation; water quality trading markets
    - Aviah: mapping Mendota sediment profile
    - Hilary: Mendota GLM modeling; big data conversations related to LAGOS and WI lake associations
    - Jen: broad ranging conversations about lake associations; interested in WI database of lake associations
    - Nicole: Sunapee GLM modeling, meeting with LSPA regularly; spatial heterogeneity of DO patterns and primary respiration (could be useful to hedonic model), bringing qualitative and quantitative data together with Mike & Leah
    - Armen: simulations with distributed modeling, a lot more can be done with the data in terms of publishing Cycles-PIHM coupling (an extra paper that can come out through CNH); conversations about simplified models (e.g., emulators) and can these be scaled up, simplified model(s) of nutrient dynamics
    - Weizhe: hedonic modeling, linkage with GLM and statistical identification of CCVs; incorporate lake association member data into hedonic model
    - Paul: long-term simulation of water quality for Mendota (first ever!) in near term (try to get high priority items done in the next few months so that Hilary can move on); scaling issues, coupling of different pieces of the project
    - Pat: scaling activities (same as Joe's items); simple models at regional scales – how can we do that with information we've gleaned from LAGOS statistical modeling as well as detailed process-based modeling
    - Kait: GLMing
    - Chris: how do we synthesize passing of information in a digital way? Emulators extract elements of watershed to simplify modeling process; Lele will be coupling hydrology to a cellular automata land-use change model as postdoc on the project
    - Yu: finish simulation for Mendota; using LAGOS database to inform hydrologic analysis, land-use change from 1984-present

    - Eric: Chris Solomon CNH proposal looking at fisheries management and lake organziations
    - Kathie: case study of Sunapee, how does it scale to other lakes; could there be a biogeochemical model for forested landscapes as well as PIHM?
- Things to include in next year's workshop
    - Time for new ideas
    - Spinoff proposal – when do we start discussing?
    - Sharing data digitally
    - Engaging lake associations, will structure look different?
    - Theme: model visualization
    - Mini tutorials at a high level to expose team members to model structure and function (higher level)
    - Video of model tutorials aimed at citizen scientists (?)
    - Video calls monthly (access to Zoom?)
    - Are there supplemental funds available through CNH? Ask program officer. Could they fund workshops? Up to 20% of project budget. Could we co-schedule with ESA or AGU? Put out a call quarterly to ask about need for workshop(s).
- Sunapee model
    - PIHM has model and results, but not calibrated; looking for a higher resolution version to capture smaller streams (end of fall semester); could be beneficial to have a team meeting in Sunapee; set videoconference with LSPA to reality check the PIHM model
    - GLM calibration in 2 months
    - Hedonic this summer (with observational)
- Delegate Zoom set-up to Pat