Report for 2001MI2561B: Building a Landscape Context for Lake Ecological Processes

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Report Follows:

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TITLE OF PROJECT: Classifying Michigan lakes by integrating fish assemblages, landscape features and water quality

Progress made by objective.

Objective 1: Organize lakes into landscape context 'groups' and develop landscape-context model
For this objective, we must first build the landscape-context database as well as the lake variable databases to test the model; and then develop the landscape-context model. We have collected all of the relevant databases (see below), and are just now starting to develop the model.

Description of databases:

Michigan Lakes GIS data coverage
All lakes given a Humphreys-Green code (new-key code). Includes the lake coverage, lake area, and location information.

Landscape-context GIS data coverage:
For the above lakes, various landscape context variables have been collected and added to a new table (ecoregion, watershed area, land use, % wetland, groundwater input, landscape position, etc.)

Historic fish database:
Based on MIDNR Fisheries Division historical fish mean length at age summaries that have been entered electronically from records at the IFR or obtained from the MIDNR Fisheries Division Fish Collection System. The database includes mean length at age estimates for a number of fish species from ~598 (of the ~700 STORET) lakes collected during ~1960-1999.

Water quality data from STORET:
Public lakes that were sampled by the DEQ in the 1970-1980's as part of their monitoring program. About 700 lakes >20ha (all public) were sampled at some point in this time period. Data include total phosphorus, total nitrogen, alkalinity, chlorophyll, Secchi, average depth.

54-Lake macrophyte field database from 2001-2002:
Lakes were chosen in a stratified-random design based on Secchi depth, mean depth and lake size.

Remotely-sensed Secchi and plants from 2001:
Using Landsat images from 2001, Secchi depth and plant cover will be estimated in as many lakes as possible from Landsat images. Only lakes within 3 Landsat images in a single path can be used (this results in many of the lakes of the lower peninsula, but not all).

Citizen Lake Monitoring Secchi data(historical):
About 70 lakes throughout the state have Secchi data from this program with > 8 years of data. Laura is currently compiling these data into an Access database.

Objective 2: Test hypothesis 1
We will determine if lake chemistry and biological variables are predicted by the landscape-context model. This objective will be completed once objective 1 is completed.

Publications that have resulted from this research.

Although no publications were published last year from this research activity, we have several manuscripts in progress that will be submitted in the coming year.

Manuscript 1: Predicting lake water quality and macrophyte cover from multi-scaled landscape features.

Data:
Landscape features (PREDICTOR variable) – Local, subregional, and regional landscape variables (such as: watershed area, lake area, lake mean depth, ecoregion, lake order/landscape position, groundwater input, lake connectivity to streams, etc.). Data obtained from Michigan lakes GIS data coverage (Breck) and Landscape-context GIS data coverage (Soranno).

Water quality variables (RESPONSE variable) – Variables such as: total phosphorus, chlorophyll, Secchi depth and alkalinity. Data obtained from STORET data of ~700 public lakes from 1980's-era data collection (Breck). [If there is a problem with using old STORET data, then we may just use present-day CLMP data (Secchi only) from 2001. However, alkalinity data (from the 1970-80's is OK to use since alkalinity doesn't change much through time.]

Macrophyte % cover (RESPONSE variable) -- Collected from remotely sensed data (Nelson) for as many of the 700 lakes as possible, OR collected from 54 lakes sampled in 2001 and 2002 (Cheruvelil) if the remote sensing approach doesn't work.

Analysis: Hierarchical linear modeling (multiple landscape features as predictor variables; individual water quality and macrophyte variables as response variables). Each water quality/macrophyte response variable will have its own model developed. Hopefully, an overall model can be determined, but individual models must be analyzed first. This is analogous to a multiple regression approach, so we will NOT come up with lake classes per se. Rather we are looking for what explains the most variability in the response variables. However, we could take these results and the variables that are significant and they could form the basis for a lake classification effort afterwards. It will be interesting to compare our approach to the approach by Wiley and Seelbach for streams.

Estimated completion date: **December 2002**

Manuscript 2: Predicting fish growth rates using landscape, water quality and macrophyte variables.

Data:

Landscape features (PREDICTOR variable) – Local, subregional, and regional landscape variables (such as: watershed area, lake area, lake mean depth, ecoregion, lake order/landscape position, groundwater input, lake connectivity to stream, etc.). Data obtained from Michigan lakes GIS data coverage (Breck) and Landscape-context GIS data coverage (Soranno).

Water quality variables (PREDICTOR variable) – Variables such as: total phosphorus, chlorophyll, Secchi depth and alkalinity. Data obtained from STORET* data of ~700 public lakes from 1980's-era data collection (Breck). [If there is a problem with using old STORET data, then we may just use present-day CLMP data (Secchi only) from 2001. However, alkalinity data (from the 1970-80's is OK to use since alkalinity doesn't change much through time.]

Macrophyte % cover (PREDICTOR variable) -- Collected from remotely sensed data (2001 Landsat images) for as many of the 700 lakes as possible, OR collected from 54 lakes sampled in 2001-2002 (Cheruvelil) if the remote sensing approach doesn't work.

Fish growth rates (RESPONSE variable)– Fisheries Division historic database (Nate) on the 700 above lakes that have STORET water quality. Analysis will be conducted for all species for which there are adequate data. [Will have to restrict fish growth data to lakes sampled as recent as possible to match plant data - in 1990's].

Analysis: Hierarchical linear modeling (multiple landscape features, water quality and macrophytes as predictor variables), and separate models for each fish species-specific growth parameter. Will also do the analysis just using landscape variables to see if landscape alone can predict fish growth. Then, water quality and plants will be added as additional predictor variables, allowing us to compare the relative ability of landscape versus internal lake features to predict fish growth. This is analogous to a multiple regression approach, so we will NOT come up with lake classes/groups per se. Rather we are looking for what explains the most variability in the response variable, i.e. fish growth.

Estimated completion date: **Summer 2003**

Outside sources of funding related to this research

We have received a research grant beginning August 2002 titled: *Managing Michigan Lakes: Evaluating Effects of Watersheds and Habitat Perturbation on Lake Resources* (Bremigan and Soranno, $183,000), funded by the Michigan Department of Natural Resources – Fisheries Division. This funded grant is very complementary to our ongoing efforts and will augment some of our research objectives in this project.