GLEON breakout group on Benthic-Pelagic Links
12 February 2008

Sondes provide an unparalleled opportunity to monitor whole-ecosystem metabolism and to link ecosystem metabolism to physical and climactic drivers at multiple time scales. However, the deployment of sondes at a single mid-lake station perpetuates a pelagic focus in limnological studies. It is not clear how well a single mid-lake sonde either detects or integrates a littoral metabolic signal, but the capacity to do so is almost certainly a function of lake size and mixing regime.

Physical size strongly determines the biological structure and function of ecosystems. Nevertheless, ecosystem extent and shape are rarely explicitly treated as drivers of lake dynamics. While it is recognized that the ratio of lake bottom surface area to water volume declines dramatically across the vast gradient of lake-size on Earth, there are few theoretical or empirical treatments of the influence of this most basic scale relationship on lake ecosystem function. Lake food webs are closely linked to littoral processes but the manifestations of these links changes with lakes size, and the biological structure of food webs varies with latitude. Sondes are one of many tools available for elucidating these large-scale patterns but doing so almost certainly requires the deployment of (minimally) one sonde in the littoral zone of monitored lakes and the availability of bathymetry/littoral habitat data for sensored lakes.

A. Habitat links in lakes: Scientific questions

*denotes questions that require targeted sonde deployments across many lakes with more than 1 sonde per lake.
** denotes questions that may be addressed with currently deployed sondes
‡ denotes questions that are linked to climate change
1) How will integration of littoral zone increase our understanding of lake ecosystems (and how do we overcome scientific resistance to the need to integrate littoral processes into conceptual models of lake ecosystem function)
2) How does lake size and shape affect the strength and direction of links between littoral and pelagic habitats?

- Nutrient cycles
- Food web structure
- Energy flow

3) *‡Can we predict the strength/frequency of littoral-pelagic nutrient links based on physical stratification and mixing?

- Polymictic lakes
  - frequent / continuous fluxes between sediments and open water?
  - little clear distinction between littoral and pelagic habitats?
- Stratified lakes with well mixed epilimnia
  - importance of internal waves in causing fluxes across thermocline?
  - Fluxes from littoral zone dependent on redox dynamics of littoral sediments?
  - Effect of littoral zone on deep hole metabolism dependent on lake size

- Very large lakes with different cells in littoral and open water zone (horizontal mixing)
- How can we design a measurement program that provides the needed information to test the role of physical forces for the benthic pelagic coupling?

4) *‡How will regional-scale changes in fluxes of DOC differentially affect littoral and pelagic productivity and decomposition as a function of changes in water clarity?
5) How does the strength and direction of benthic-pelagic coupling change with the alternating stable states in shallow lakes?
6) *‡Does the strength of benthic-pelagic coupling change predictably with latitude based on changes in food web structure
7) **Can persistent among-lake variation in deep hole sonde signal be attributed to benthic signal
8) Can lakes be categorized based on the biotic (macrophyte, microphytobenthos, woody debris) or physical (edaphic) structure of littoral habitats?

B. Habitat links in lakes and sondes: Technical/practical considerations

1) What data are currently available from multiple sonde deployments in a single lake?
2) Can mid-lake deployments detect a littoral signal?
3) Are adequate morphometric data available for determining distribution of sediments with depth in lakes where sondes are currently deployed?
4) Over what depths are light data available?
5) How can we design a measurement program to improve our information about nutrient fluxes between sediment by installing relevant sondes near the sediment surface (nutrients, current, oxygen, etc.).
6) Can we get sufficient information about resuspension measurements from turbidity measurements or do we need additional sampling with high frequency samplers where sampling is automatically initiated at relevant wind speed/direction.
7) How can we maximize a one-sonde design (the current set-up in most GLEON lakes) to understand littoral-pelagic/benthic-pelagic ecological questions?
8) How do multiple sonde deployment estimates of benthic and pelagic metabolism compare with other methods?

- Oxygen chambers
- Pulse Amplitude Modulated Fluorometry

C. Habitat links within GLEON

1) High student interest
2) Within group interest for working group to continue
3) How do we convince other GLEON groups of need for incorporating habitat variability into ecosystem concepts

- Interdisciplinary links (e.g., DOC, microbial ecology, ecosystem production, food webs)
- Variation in nature/strength of benthic signal with ecosystem size

- Variation in behavior of pelagic signal may actually reflect benthic dynamics (e.g., recruitment of algae from benthos, benthic insect emergence, benthic subsidizing of fish and zooplankton, nutrient variability from internal loading).

D. Near future products/leaders

- Definitions/evaluation of habitat links across a lake-size gradient (EJ/YV in progress TREE article)
- Assessment of use of oxygen sensors in shallow lakes compared with mechanistic models of production (EJ, YV).

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