Nutrient loading to Wabamun Lake

Information Session 2.1-2

NON-POINT SOURCES of nutrients to Wabamun Lake:

Origins, implications, potential actions

Overview of nutrient loading (2.1) sessions

- **2.1 The implementation of a program designed to prevent further increases of external loading to Lake Wabamun. *(SR)***
- **3 sessions over next 3 meetings**
  1. **Point sources of nutrients**
  2. **Non-point sources of nutrients**
  3. **Management options, discussion**

Outline – Non-point source session

- **Revisit: Background: Nutrient-lake links**
- **Revisit: Wabamun Lake: Nutrient conditions**
- **Nutrient non-point sources and Wabamun Lake**
- **External nutrient loading: implications and potential actions for Lake Wabamun**

Revisit: Background: Links between nutrients and lakes

What are nutrients?

- **Particulate or dissolved molecules that can be used by living organisms to extract energy. Also used as molecular building block for growth.**
- **Macronutrients (essential for life in large amounts)**
  - **Carbon, hydrogen, oxygen, phosphorus, nitrogen; others (sulfur, potassium, calcium, sodium, silica, magnesium, chlorine)**
- **Micronutrients (essential for life in small amounts)**
  - **Iron, copper, iodine, manganese, zinc and others**
- **Limiting nutrient**
  - **A nutrient (usually macronutrient) in insufficient quantities to sustain growth**
  - **If potential limiting nutrients are in excess, growth with continue and possibly become excessive**

Nutrient pathways to lakes

- **There are several natural and human-related nutrient inputs to lakes:**

Natural macronutrient sources to lakes

- **Precipitation → both wet and dry sources**
- **Local runoff → via rivers, creeks, flow through upper soil**
- **Groundwater → shallow and deep**
- **Internal → animals, plants, release from sediments**

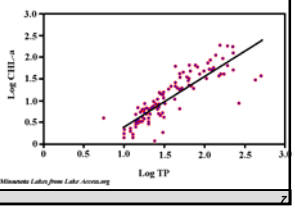
Human macronutrient sources to lakes

- **Precipitation → pollution as particles/gas into rain/snow**
- **Local runoff → agriculture, domestic, clearing, construction**
- **Groundwater → spills, improper infrastructure**
- **Direct discharge → sewage, grey water**

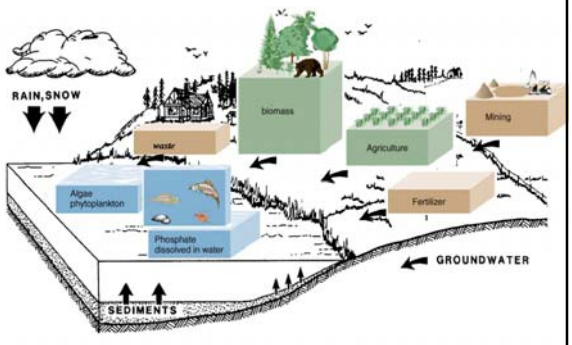
Nutrients and ecosystem productivity

Nutrients in lakes

- Food (energy) for the entire ecosystem is mostly supplied by primary producers (pp)
  - aquatic plants, floating/attached algae, others
- In freshwater systems, phosphorus the most common limiting nutrient to pp growth; N rarely
- Total Phosphorus loading to lakes is well correlated to chlorophyll-a concentration (productivity)

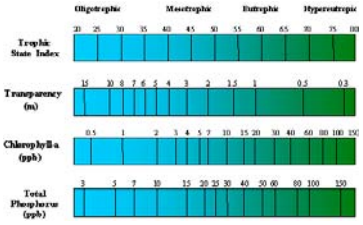


Phosphorus Cycle



Lake trophic status

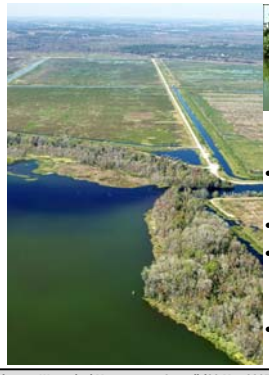
- Lake trophic state: characterization of lakes based on the primary productivity of the lake; can be:
  - Oligotrophic – low in nutrients (TP) and productivity (Chl-a)
  - Mesotrophic – moderate in nutrients and productivity
  - Eutrophic – high in nutrients and productivity
  - Hyper-eutrophic – excessive in nutrients and productivity



Lake stable states: plants vs. plankton

- It has been well established that shallow, eutrophic lakes generally show two stable states:
  - Clear water state, dominated by aquatic plants
  - Turbid water state, dominated by algae
- Switching between states has been studied in many lakes (Moss 1990; van Donk and Gulati, 1995; Blindow et al., 1992) and results generally show switches result from nutrient loading and additional stresses (lake levels, harvesting, etc.)

CASE STUDY: LAKE APOPKA, FLORIDA



- Former aquatic plant dominated lake
- Heavy nutrient inputs
- 1947 Hurricane stirred nutrient-rich sediments and uprooted plants
- Became an algae dominated system (hypereutrophic)

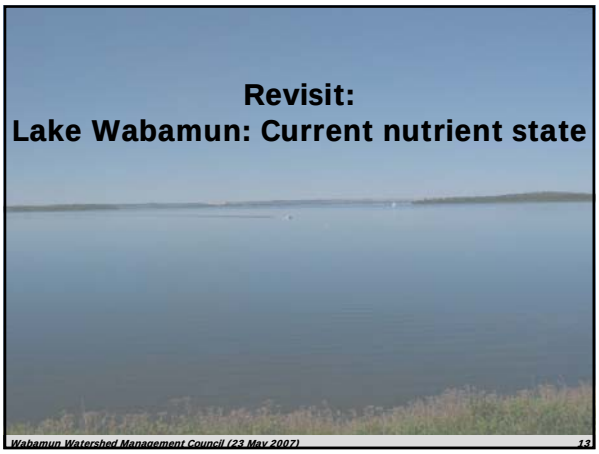
Why is nutrient loading a problem?

Ecosystem impacts

- Eutrophication
  - →Blue-green algae blooms (cyanobacteria)
  - →Green, filamentous green algae
  - →Excessive plant growth
  - Toxicity in water column and sediments
  - Lower oxygen at depth (fish kills)
  - Disturbed food webs
  - Increased turbidity, affects predation

Human impacts

- Nuisance algal blooms
- Algae toxicity
- Property value and recreational effects
- Growth of non-native aquatic plants
- Illness/death of domestic animals



Wabamun Lake nutrients: AENV Monitoring

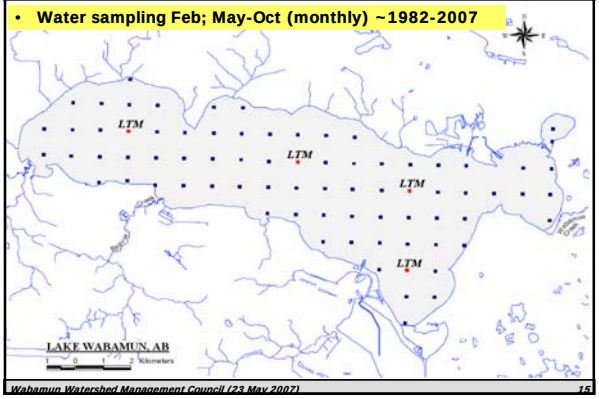
Phosphorus
- Total phosphorus (TP)
- Total dissolved phosphorus (TDP or dP)

Nitrogen
- Total ammonia (NH4+)
- Nitrate-Nitrite (NO3-NO2)
- Total Kjeldahl nitrogen (TKN)

Silica
- Dissolved reactive silica (dSi)

Wabamun Lake nutrients: Monitoring

- Water sampling Feb; May-Oct (monthly) ~1982-2007

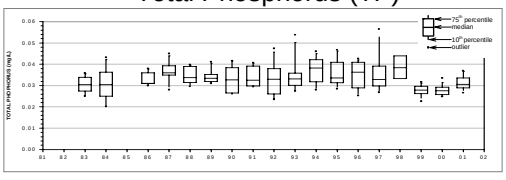


Wabamun Lake nutrients: Monitoring

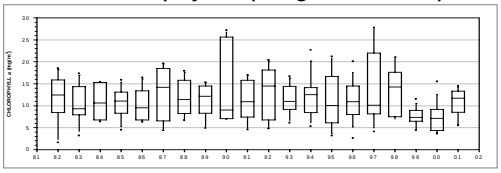
Summary of Observations Nutrients and Chlorophyll-*a*

- Nutrient levels (phosphorus and nitrogen) remained fairly stable from 1982 to 2001
- Small decrease in phosphorus and Chlorophyll-*a* coincides with operation of Water Treatment Plant
- Lake remains moderately to highly productive

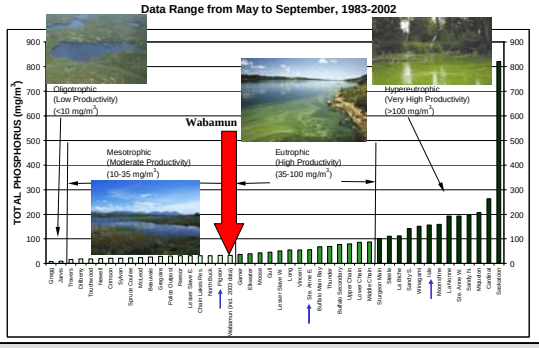
Total Phosphorus (TP)



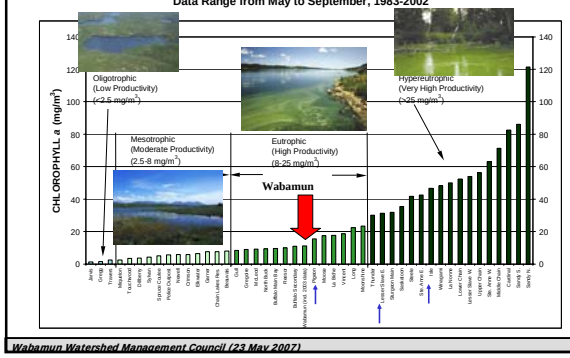
Chlorophyll-*a* (~Algal Biomass)



Wabamun Trophic Status – TP

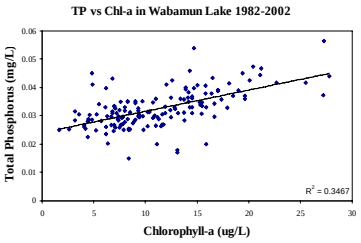


Wabamun Trophic Status – chlorophyll-a



Nutrients and ecosystem productivity

- **Total Phosphorus loading to lakes is well correlated to chlorophyll-a concentration: Wabamun generally fits paradigm**
- **Like most other lakes in Alberta, phosphorus is limiting to Wabamun primary production**



Phosphorus and sources

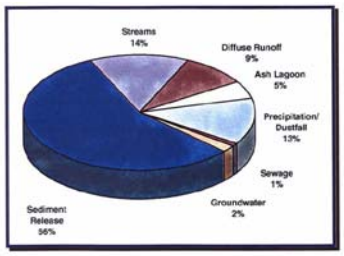


Figure 5. Total phosphorus loading to Wabamun Lake (1980 and 1981). From Golder (1997)- Data are from Mitchell (1985).

Phosphorus and sources

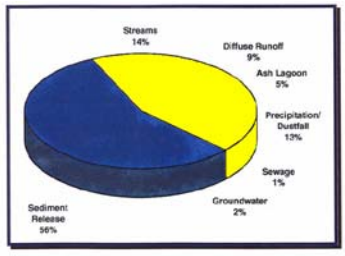
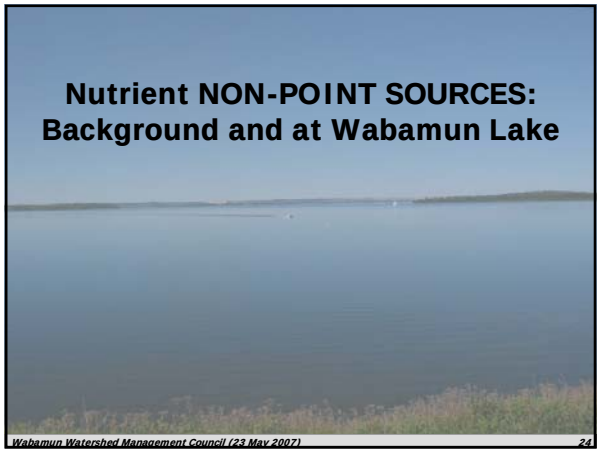


Figure 5. Total phosphorus loading to Wabamun Lake (1980 and 1981). From Golder (1997)- Data are from Mitchell (1985).

Nutrient NON-POINT SOURCES: Background and at Wabamun Lake



What are non-point nutrient sources?

- Diffuse nutrient sources (i.e. without a single point of origin or not introduced into a receiving stream or lake from a specific outlet).

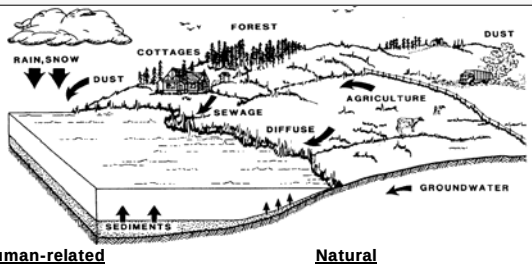


Point vs. Non-point Sources

- Often a matter of definition
  - Non-point sources near lake?
  - Point sources far from lake?
- Often the most important source of nutrients to a system
- The least regulated, compared to point sources
- Treatment often more challenging than point-source and results may be measured on a much longer scale
- Everybody's responsibility!



Non-point nutrient sources in watersheds



Human-related
- Livestock/domestic runoff
- Lawn fertilizer runoff (large area)
- Road salting/sand runoff
- Diffuse septic tank leakage

Natural
- Groundwater
- Precipitation (wet, dry)
- Dust/sediment transport
- Natural runoff
- Lake sediments

Wabamun L. non-point nutrient sources?

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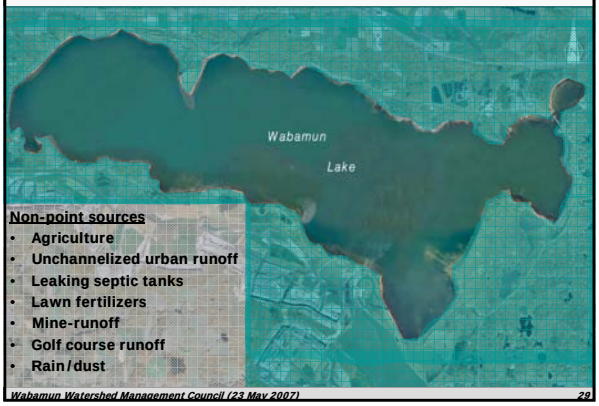
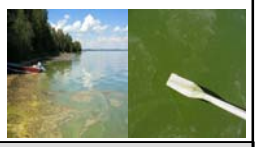


Non-point sources
- Agriculture
- Unchannelized urban runoff
- Leaking septic tanks
- Lawn fertilizers
- Mine-runoff
- Golf course runoff
- Rain/dust

External nutrient loading from non-point sources to Lake Wabamun: implications and possible action

Implications of external nutrient loading: Lake and watershed ecosystem

- **Currently, phosphorus in Wabamun is at levels sufficient to sustain aquatic plant and algae growth**
- **Continued loading and other stresses may induce change in stable state (Jeppesen et al., 1999)**
- **This may lead to more frequent and extensive algae blooms**
- **This has implications for:**
  - **Fish (O2 depletion)**
  - **Toxicity to benthic and littoral species**
- **Nutrient increases can also exasperate growth of aquatic plants**



Implications of external nutrient loading: Human health, use, recreation

- **Some human effects due to external nutrient loading and possible increases in blue-green algal blooms:**
  - Possible releases of toxic compounds which can cause rashes, skin and eye irritation, allergic reactions, gastrointestinal upset, and other effects. At high levels, exposure can result in serious illness or death due to organ and neural toxicity
  - Unpleasant odours
  - Pet/livestock illness and death
  - Swimming bans
  - Fish consumption restrictions
  - Coating of recreational equipment
  - Loss of property value!

Challenges to reducing non-point sources

- **Diffuse entry to lake (how to recognize source & entry)**
- **Tougher to enact change in behaviours than point source**
- **Aesthetic grooming of property (i.e. fertilizers)**
- **Lack of lake flushing to keep nutrients from concentrating**
- **Infrastructure/mitigation time and costs**
- **Money for detection and replacement of poor septic systems**
- **Golf course and mining operations**

Ideas for action-Education & Outreach

- **Develop initial information packages outlining the effects of various nutrient point sources and suggestions of alternative actions. This may cover such issues as:**
  - **Agriculture-manure management information**
  - **Implementation of best practices for farmers**
  - **Shrub/tree planting program along shorefront (erosion as well)**
  - **Watershed-wide fertilizer reduction programs**
  - **Limit livestock access to riparian areas**
  - **Partner with Alberta Agriculture**

- **Public information sessions, booths that extend nutrient management information. Possible event attendance:**
  - **Farmers' Market**
  - **Others?**

Ideas for action-Incentives,Infrastructure

Infrastructure investment:

- **Early response street sweeping**
- **Sediment management at launches and docks**
- **Septic monitoring equipment to evaluate septic performance**
- **Holding facilities for urban storm water**

- **Incentive programs:**
  - **Plant riparian vegetation to buffer nutrients**
  - **Encourage golf course to get environmental certification (nutrient control)**
  - **Plantation of shrubs/grasses along transport corridors**

Ideas for action-Enforcement/monitoring

- **Enforcement program:**
  - **Likely limited unless bylaws directed at watershed management are passed**

- **Monitoring programs:**
  - **Expansion of current programs to include point source monitoring**
  - **Increased Capital Health monitoring**

Questions, discussion?

REFERENCES

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