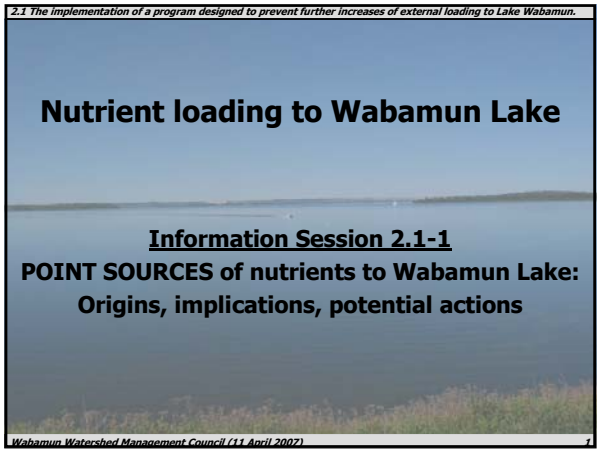


Nutrient loading to Wabamun Lake

Information Session 2.1-1

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 – Point source session

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

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**

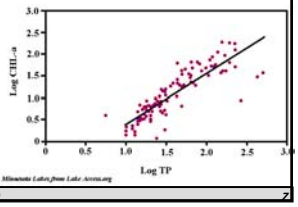
Human macronutrient sources to lakes

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

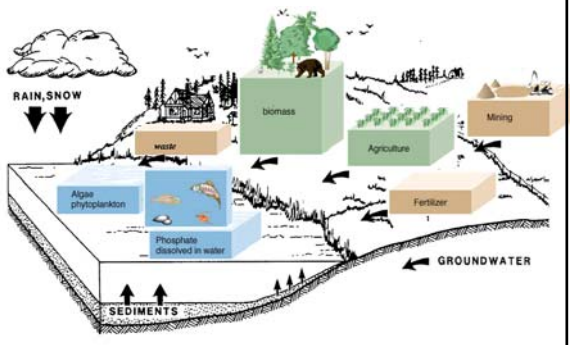
Nutrients and ecosystem productivity

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)**

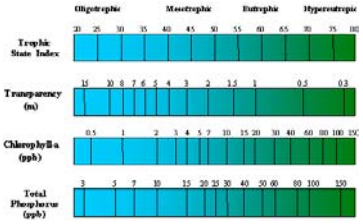


Phosphorus Cycle



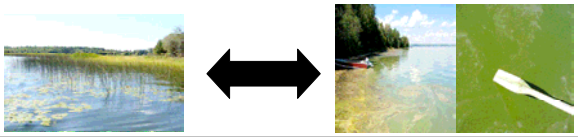
Lake trophic status

- **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)

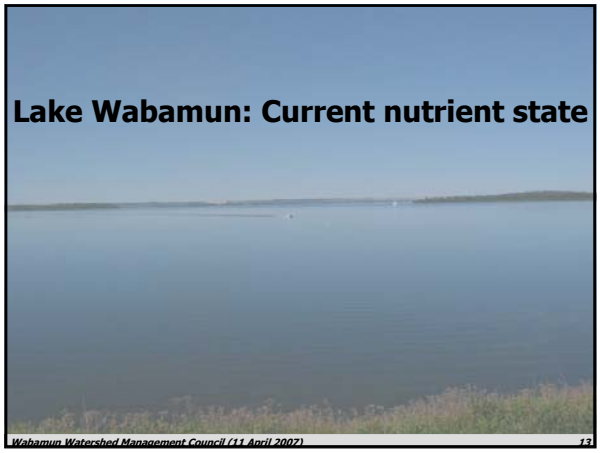
Why is nutrient loading a problem?

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

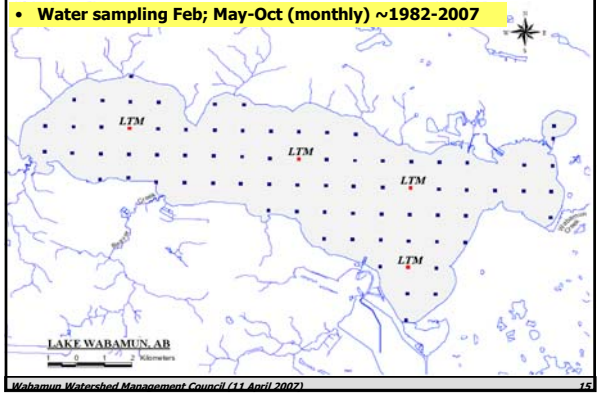
Phosphorus
- Total phosphorus (TP)
- Total dissolved phosphorus (TDP or dP)

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

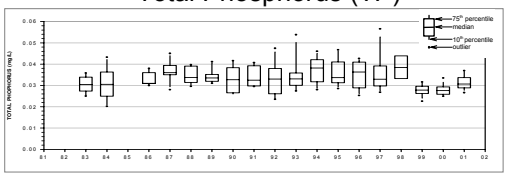


Wabamun Lake nutrients: Monitoring

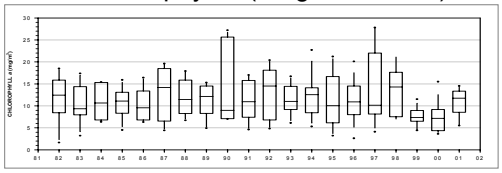
Summary of Observations Nutrients and Chlorophyll-*a*

- 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

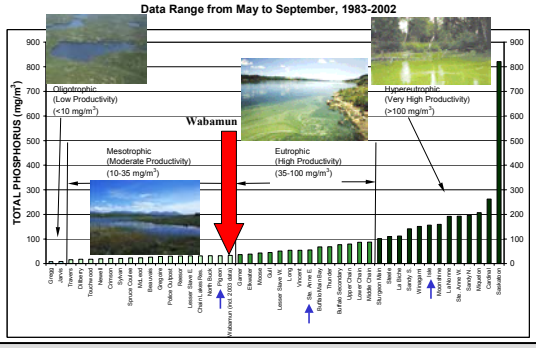
Total Phosphorus (TP)



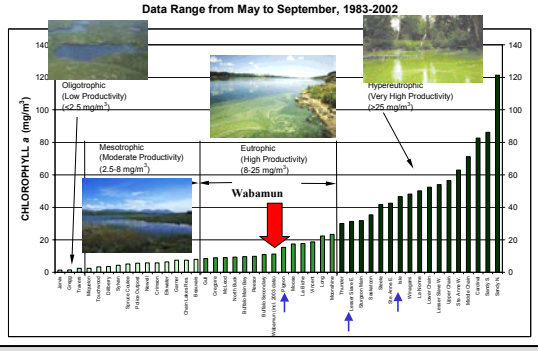
Chlorophyll-*a* (~Algal Biomass)



Wabamun Trophic Status – TP

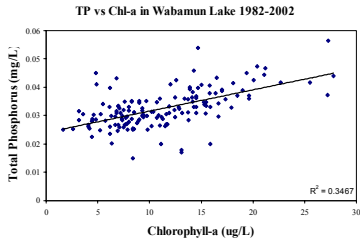


Wabamun Trophic Status – chlorophyll-a



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

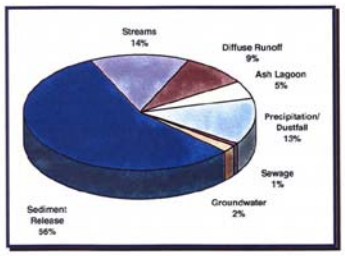


Figure 5. Total phosphorus loading to Wabamun Lake (1980 and 1981). From Golder (1997)- Data are from Mitchell (1985).

Phosphorus and sources

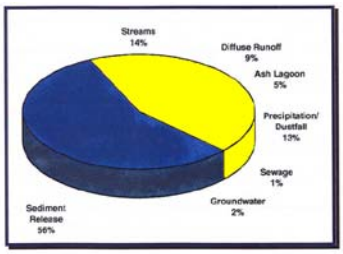


Figure 5. Total phosphorus loading to Wabamun Lake (1980 and 1981). From Golder (1997)- Data are from Mitchell (1985).

Nutrient POINT SOURCES: Background and at Wabamun Lake

What are point nutrient sources?

- **Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft from which pollutants are or may be discharged**

Point nutrient sources in watersheds



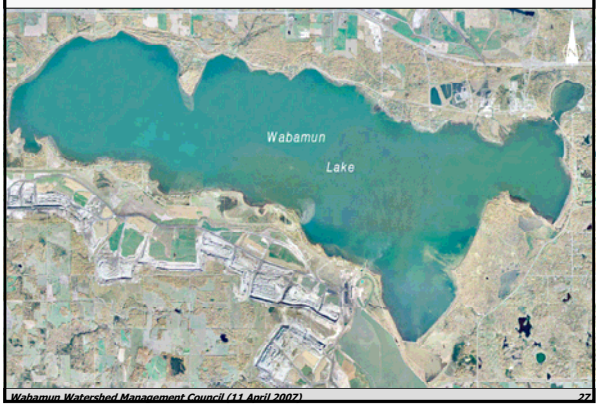
Human-related

- **Municipal effluents**
- **Holding pond discharge**
- **Bilge/sewage vessel discharge**
- **Illegal dumping/spills**
- **Industrial-related effluent**

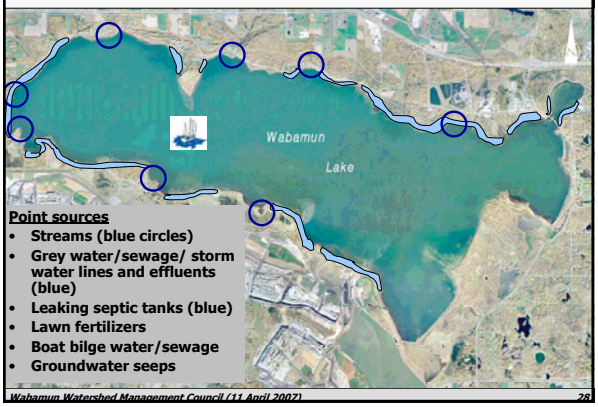
Natural

- **Inflow streams**
- **Precipitation**
- **Groundwater seeps**


Wabamun Lake point nutrient sources?



Wabamun Lake point nutrient sources?



Point sources

- **Streams (blue circles)**
- **Grey water/sewage/ storm water lines and effluents (blue)**
- **Leaking septic tanks (blue)**
- **Lawn fertilizers**
- **Boat bilge water/sewage**
- **Groundwater seeps**

AENV Approved municipal discharges

Facility	Discharge Frequency	location
Village of Wabamun	Once per year	to an unnamed creek discharging north (away from Wabamun Lake)
Village of Seba Beach	Once per year	No Discharge (Evaporation pond)
Wabamun Provincial Park	Once per year	to a drainage course and ultimately to North Saskatchewan River
Sundance Power Plant	Once per year	to plant cooling pond with blowdown to N.Sask River
Keephills Power Plant	Once per year	to plant cooling pond with blowdown to N. Sask River
Wabamun Power Plant	-	to Village of Wabamun Lagoon

External nutrient loading from 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 point sources

- **Multiple point sources throughout long shoreline**
- **Visible and submerged effluent from residences**
- **Attitudes of residents regarding lake health**
- **Aesthetic grooming of property (i.e. fertilizers)**
- **River outflow represents multitude of nutrient sources**
- **Lack of lake flushing to keep nutrients from concentrating**
- **Boating community compliance w/bilge & sewage**
- **Money for detection and replacement of poor septic systems**

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:**
  - **Lawn fertilizer application**
  - **Grey water and direct sewage lines to lake**
  - **Septic tank management and upgrading**
  - **Boating bilge/sewage management**
  - **Biodegradable product use**
  - **Controlling pet feces**
  - **Others?**

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

Ideas for action-Incentives,Infrastructure

- **<u>Infrastructure investment:</u>**
  - **Boating pump-out stations East and West on lake**
  - **Septic monitoring equipment to evaluate septic performanc**
  - **Holding facilities for storm water**
  - **Yard clipping pickup and/or composting facility**
  - **Enhanced street sweeping program from villages**
- **<u>Incentive programs:</u>**
  - **Tree/shrub planting program along lakeshore as a nutrient buffer**
  - **Septic tank upgrade grants**
  - **Support for residents to change from fertilizer to native species**
  - **Grants for septic evaluation / diversion of effluent lines**
- **<u>In-lake controls (very costly, unproven results):</u>**
  - **Aeration, dredging, harvesting, dyes, covers, biological**

Ideas for action-Enforcement/monitoring

- **<u>Enforcement program:</u>**
  - **AENV compliance visit frequency to investig direct lines to lake**
  - **Non-compliance reporting by lake residents**
  - **Capital Health investigations**
  - **AENV approvals**
  - **Municipal bylaws, enforcement**

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

Questions, discussion?

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