Lakes

- Concerns in Lakes
  - Eutrophication
  - Toxics
  - Dissolved Oxygen
- Aging of Lakes
  - Oligotrophic
  - Mesotrophic
  - Eutrophic
  - Extinction

Succession: natural course of events (eutrophication), but can be accelerated by human activities (cultural eutrophication).
Lakes and Lake Modeling

Lakes and Lake Modeling (cont.)
WQ Profiles in Stratified Lakes

Dissolved oxygen

Epilimnion
Thermocline
Hypolimnion
Manganese

Concentration

Depth

Temp. Profiles in Stratified Lakes

Winter
Fall
Spring
Summer

Epilimnion
Thermocline
Hypolimnion

Temperature

Depth
Completely mixed lake model

\[
\text{[accumulation]} = \text{[loadings]} \pm \text{[transport]} \pm \text{[reactions]}
\]

\[
V \frac{dc}{dt} = W(t) - Qc - kVc^n
\]

For a 1st order reaction (n=1):\[
\frac{dc}{dt} + \alpha c = \frac{W(t)}{V}
\]

Where: \[
\alpha = \frac{Q}{V} + k
\]

Steady State Solution: \[
c = \frac{W}{Q + kV}
\]
Stratified Lake Model

1. Epilimnion
2. Hypolimnion

\[ V_1 \frac{dc_1}{dt} = W_1 - Qc_1 + E_{12}' (c_2 - c_1) - k_1 V_1 c_1 \]
\[ V_2 \frac{dc_1}{dt} = W_2 + E_{12}' (c_1 - c_2) - k_2 V_2 c_2 \]

Thermal Lake Types vs Latitude

- From *Limnology*, by Wetzel
Lake Types

- **Amictic**: lakes permanently covered with ice
- **Cold Monomictic**: temperature is always <4°C, mixes only in summer, when T~4°C
- **Dimictic**: circulates freely twice a year, temperature ranges above and below 4°C
- **Warm Monomictic**: temperature is always >4°C. Mixes only in winter
- **Oligomictic**: warm lakes (usually tropical) with rare and irregular mixing
- **Polymictic**: frequent or continuous circulation (possibly even diurnal)

• To next lecture