Lakes 101

An Overview
of
Lake Ecology

Watershed Stewards Program

Origin of Maine Lakes

- Maine lakes were formed by advance and recession of continental glaciers
- Last recession - 12,000 years ago

Lake Origin Types

- glacial scour
- valley dams
- kettle holes
- cirques

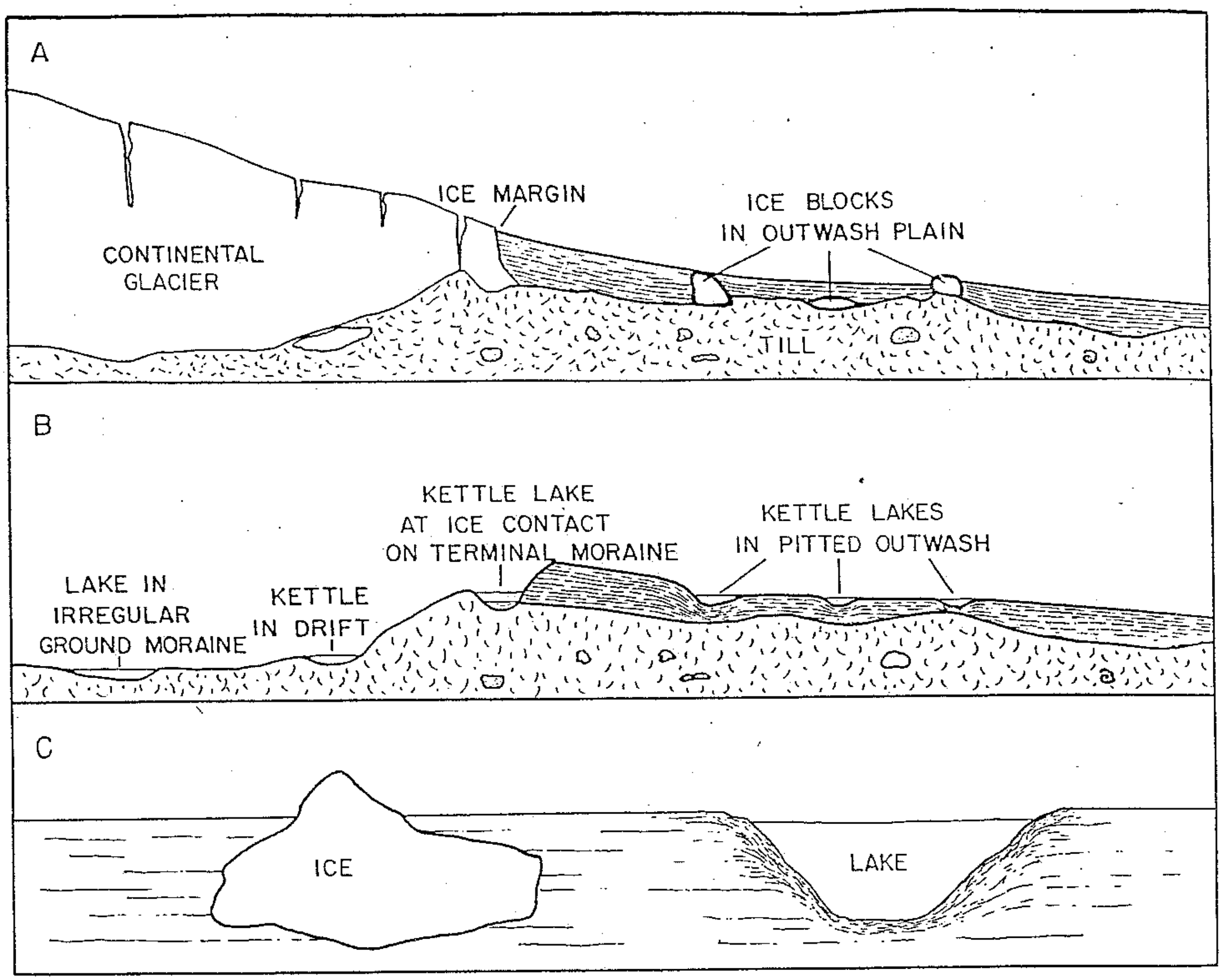

A
CONTINENTAL GLACIER
ICE MARGIN
ICE BLOCKS IN OUTWASH PLAIN
TILL
B
LAKE IN IRREGULAR GROUND MORAINE
KETTLE IN DRIFT
KETTLE LAKE AT ICE CONTACT ON TERMINAL MORAINE
KETTLE LAKES IN PITTED OUTWASH
C
ICE
LAKE

Table 2A.--Lakes grouped according to origin, using the classification system of Hutchinson (1957).

Lake Origins				
Lakes in depressions left by glacial scour (Type 26)*	Valley lakes with one end dammed by till deposits (Type 30a)*	Valley lakes with both ends dammed by till deposits (Type 30b)*	Valley lakes dammed by outwash deposits (Type 31)*	Lakes in depressions left by melting of ice blocks in outwash deposits (Type 35)
Floods Pond	Beech Hill Pond	Eagle Lake	Clearwater Pond	Beddington Lake
Lead Mtn Pond (Upper)	Branch Lake	Minnehonk Lake	Crescent Lake	Brettuns Pond
Nubble Pond	Brewer Lake	Molasses Pond	Green Lake	Crystal Lake
Pleasant Pond	Coffee Pond	Spectacle Pond	Mopang Lake	Forest Lake
Saddleback Lake	Eastern Grand Lake	Wilson Pond	Panther Pond	
	Great East Lake		Pleasant River Lake	
	Haley Pond		Porter Lake	
	Highland Lake		Pushaw Lake	
	Hopkins Pond		Shin Pond (Upper)	
	Long Pond		Webb Lake	
	Madawaska Lake		Woodbury Pond	
	Phillips Lake			
	Portage Lake			
	Raymond Pond			
	Shin Pond (Lower)			
	Tomah Lake			
	Wilson Pond (Lower)			
	Wilson Pond (Upper)			

* Hutchinson's code number for lake origins.

Lake Morphometry

- Surface Area

- Depth

  maximum
  mean

- Volume

  area x mean depth

- "Development" of Shoreline

  ratio of shoreline length to circumference of circle of same area as lake

- Landscape and Orientation

Temperature Cycles

- Spring Turnover

  uniform temperature profile

- Summer Stratification

  epilimnion
  thermocline / metalimnion
  hypolimnion

- Fall Turnover

  epilimnion gradually
  deepens until temprature is
  uniform

- Winter Stratification

  inverse stratication

Lake Morphometry and Temperature

The amount, depth and intensity of summer stratification is determined by:

- Depth of lake basin

- Exposure to wind
  - surface area
  - shape and orientation
  - surrounding topography

- Shape of bottom, bathymetry

Lake Hydrology

- Drainage Area / Watershed

  Total
  Direct

- Hydraulic Load (Q)

  DA x Runoff

- Flushing Rate

  Q / V

- Residence Time

  V / Q

Effect of Flushing Rate

Low Flushing, Long Residence

- deep w/ small watershed
- slow response
- high sedimentaion rate, pollutants lost from water column
- low dilution
- most sensitive to single source

High Flushing, Short Residence

- shallow w/ large watershed
- quick response
- low sedimentation rate, pollutants stay in water column
- high dilution
- most sensitive to watershed wide development

Lake Chemistry

- Alkalinity and pH
- Color (dissolved organic acids)
- Nutrients
  - PHOSPHORUS
  - nitrogen
  - silica
- Dissolved Oxygen
- Iron
- Mercury

Phosphorus

- Essential nutrient for life
- Limiting nutrient for algae growth in Maine lakes
- Recycled between soil and vegetation
- Attached to surface of fine soil particles
- Easily carried in stormwater runoff from all points in the watershed

Phosphorus Sources

- Atmospheric

- Watershed
  - Erosion
    - -- road ditches
    - -- camp roads
    - -- agricultural fields
    - -- forest harvesting
    - -- shoreline
  - Manure and Fertilizer
  - Urban Runoff
  - Septic Systems

- Lake Bottom Sediments

Dissolved Oxygen Cycles

Spring Turnover

- D.O. at or near sturation from top to bottom

Summer Stratification

- if lake stratifies, gradual loss of D.O. in hypolimnion and metalimnion

- rate and extent of D.O. loss depends on level of algal production and volume of hypolimnion and metalimnion

Dissolved Oxygen Cycle
(continued)

Fall Turnover

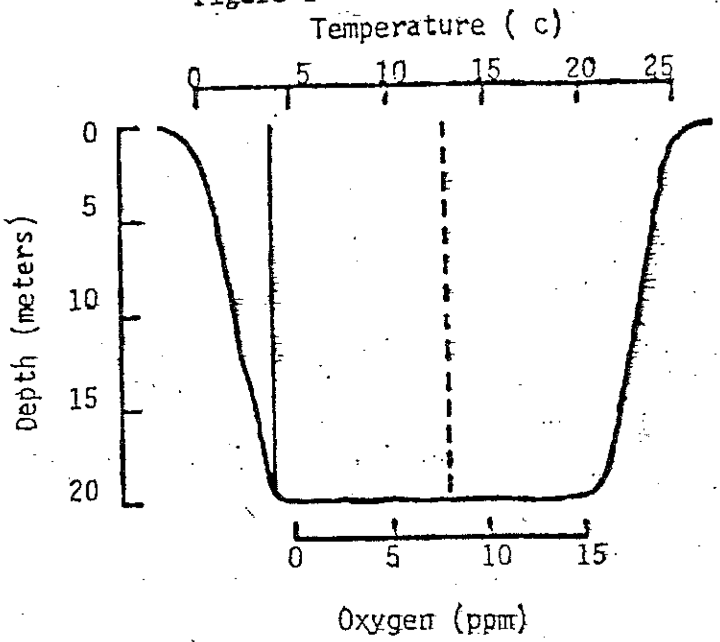
- D.O. gradually replenished in bottom waters as epilmnion deepens
- results in D.O. at or near saturation from top to bottom

Winter Stratification

- gradual loss of D.O., starting above bottom sediments and moving up into water column
- rate and extent of D.O. loss depends amount of algal and plant decay and depth of water below ice

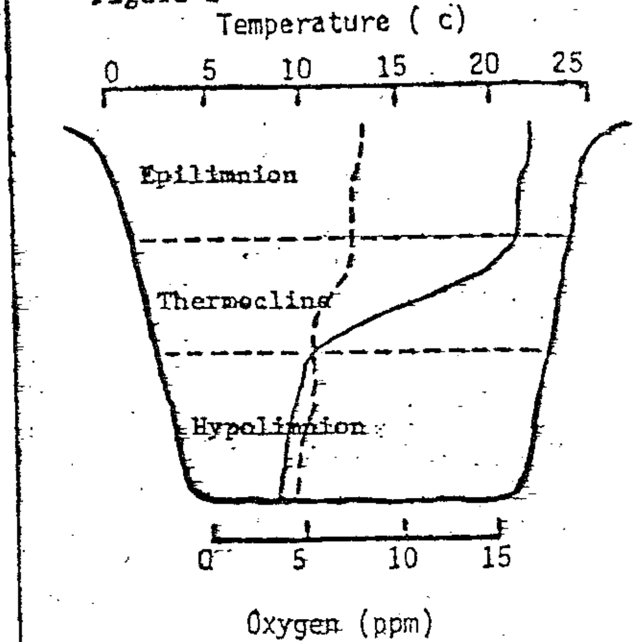
TEMPERATURE CYCLES

Figure 1



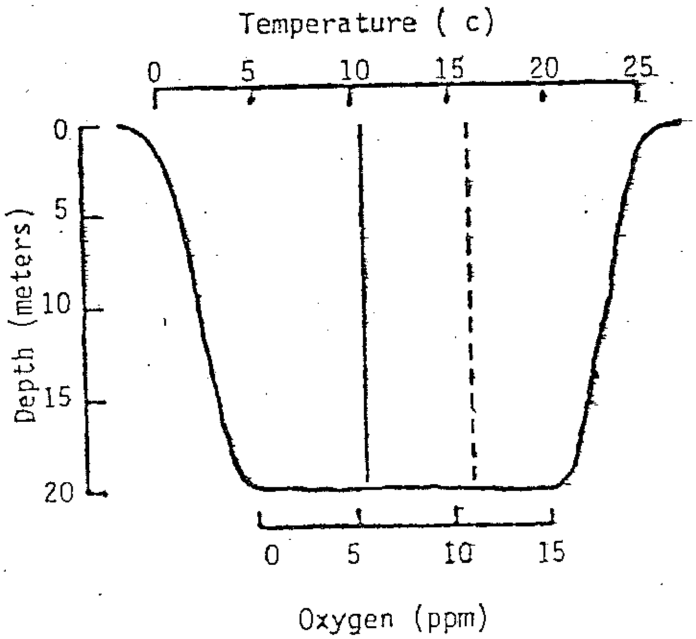
SPRING TURNOVER

Figure 2



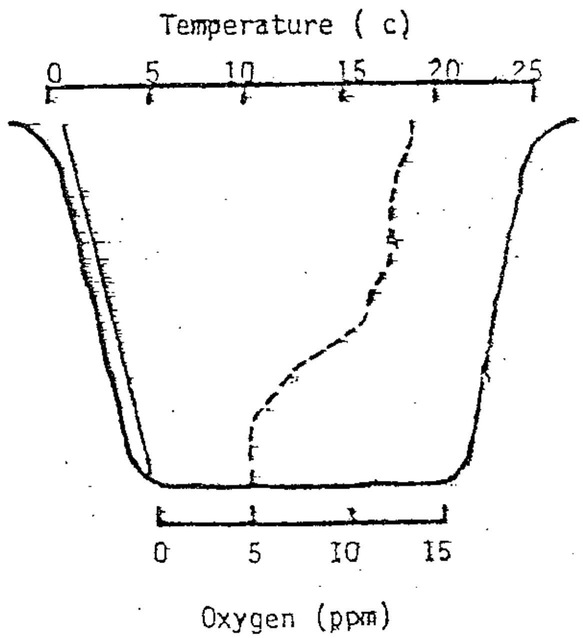
SUMMER STRATIFICATION

Figure 3



FALL TURNOVER

Figure 4



WINTER STRATIFICATION

________________ Temperature

---------------- Oxygen

Importance of Dissolved Oxygen

- Essential for all aquatic life

- In summer, coldwater fish (salmonids) need cooler metalimnion and hypolimnion to be well oxygenated

- Lake trout and salmon need ≥ 5 ppm to do well; can tolerate lower levels for short periods

- Loss of oxygen over bottom sediments allow recycling of sediment phosphorus into water column

Internal Recycling of P from Bottom Sediments

- If water above sediments is oxygenated, $Fe(OH)_3$ floc blankets sediment surface and traps P diffusing from sediments

- If oxygen above sediments 0.2ppm, floc dissolves, P is released to water column and barrier to P diffusion is gone allowing further P migration

- P release feeds algal growth, which increases oxygen depletion, setting up a viscious cycle rapid eutrophication

Morphometry, D.O. and P

Shallow Lake

- no stratification
- no significant D.O. depletion
- ephemeral recycling only

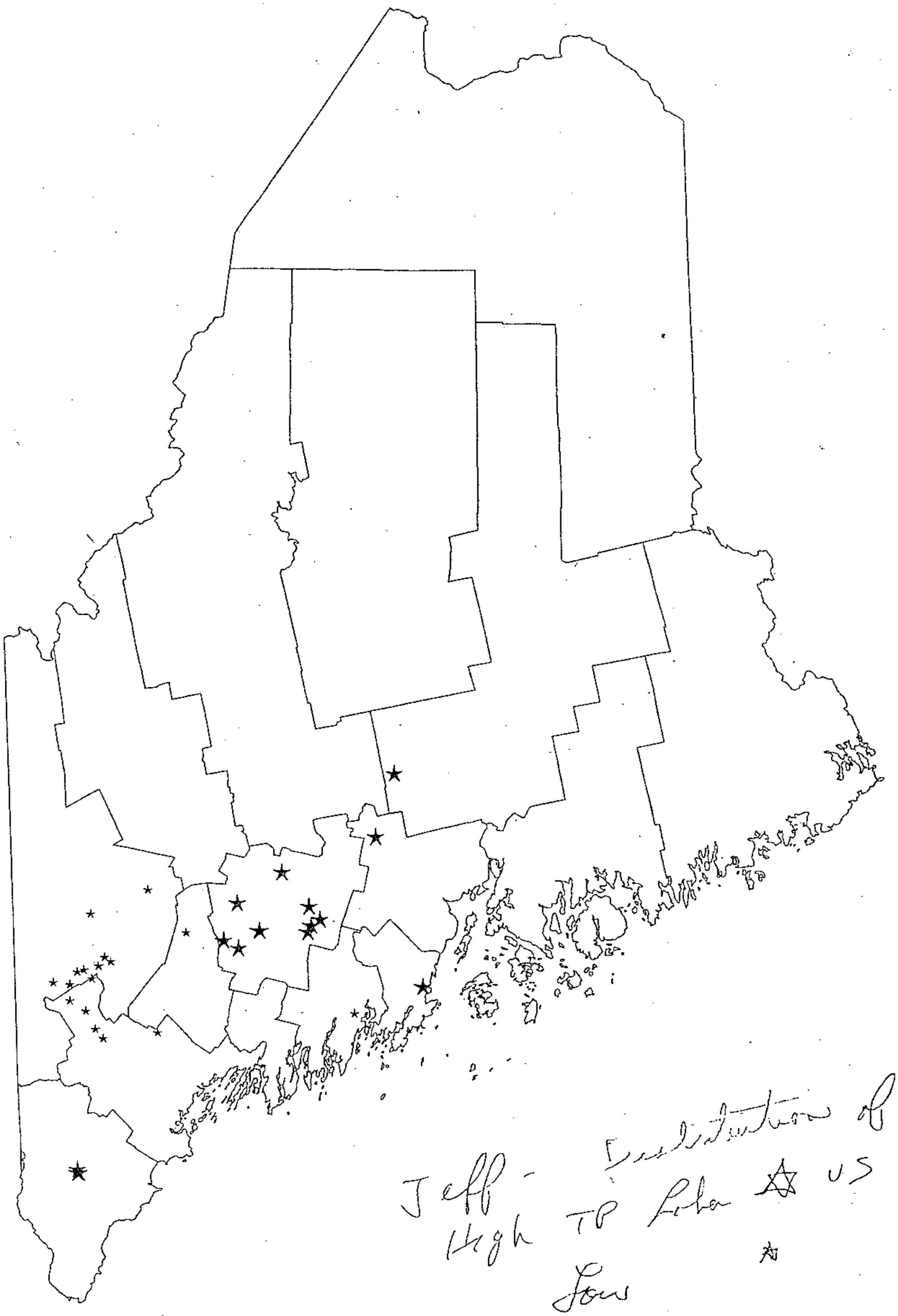
Deep Lake

- deep hypolimnion
- anoxic bottom waters, but cold water volume so large effect on fishery and phosphorus is minimal

Moderate Depth (small deep hole)

- thermocline/metalimnion but little or no hypolimnion
- severe D.O. loss in metalimnion
- <u>may</u> have high P in metalimnion
- recycled P may reach epilimnion

C:\temp\UIATC1.M



Jeff - Distribution of High TP Lakes ★ vs ☆ Low