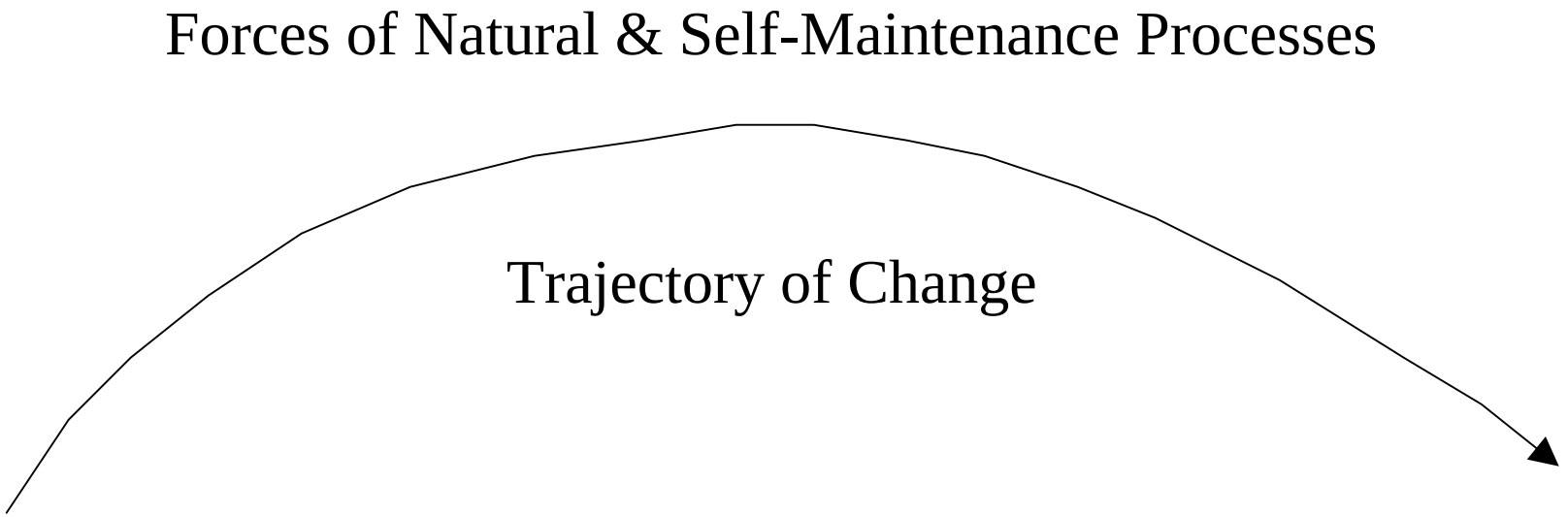
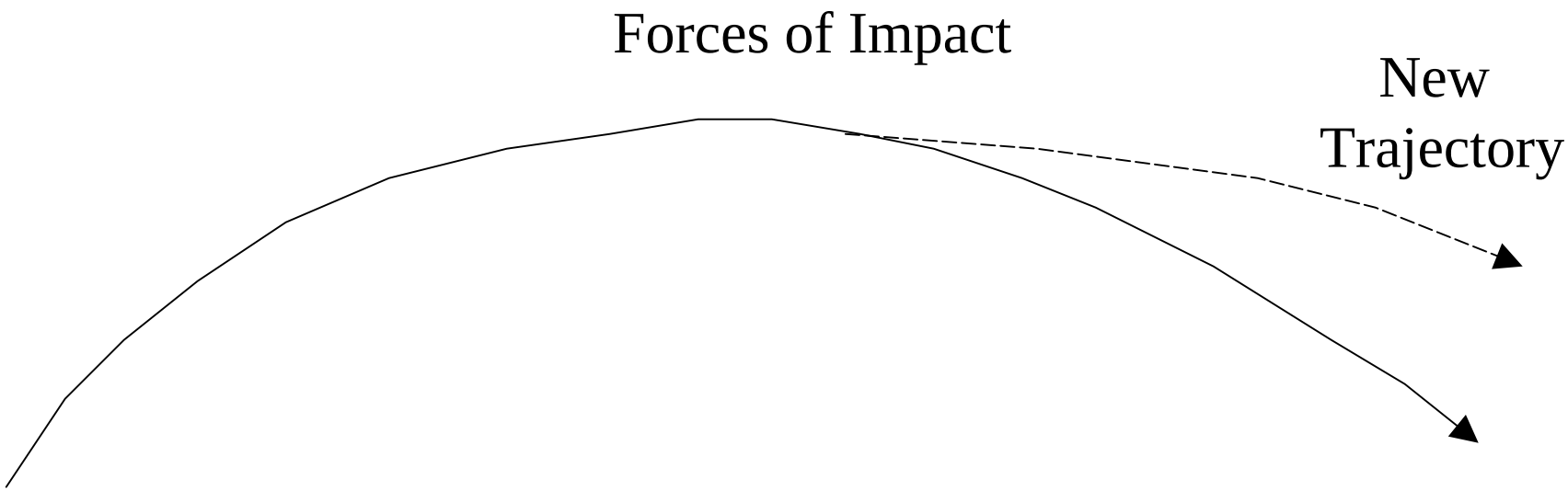
# Fresh Water Ecosystem Dynamics

- Purely Natural Ecosystems are Self-Maintained by Natural Processes
- Modified (Impacted) Ecosystems Management
  = Self-Maintenance by Natural Processes
  + Human (Technical) Management

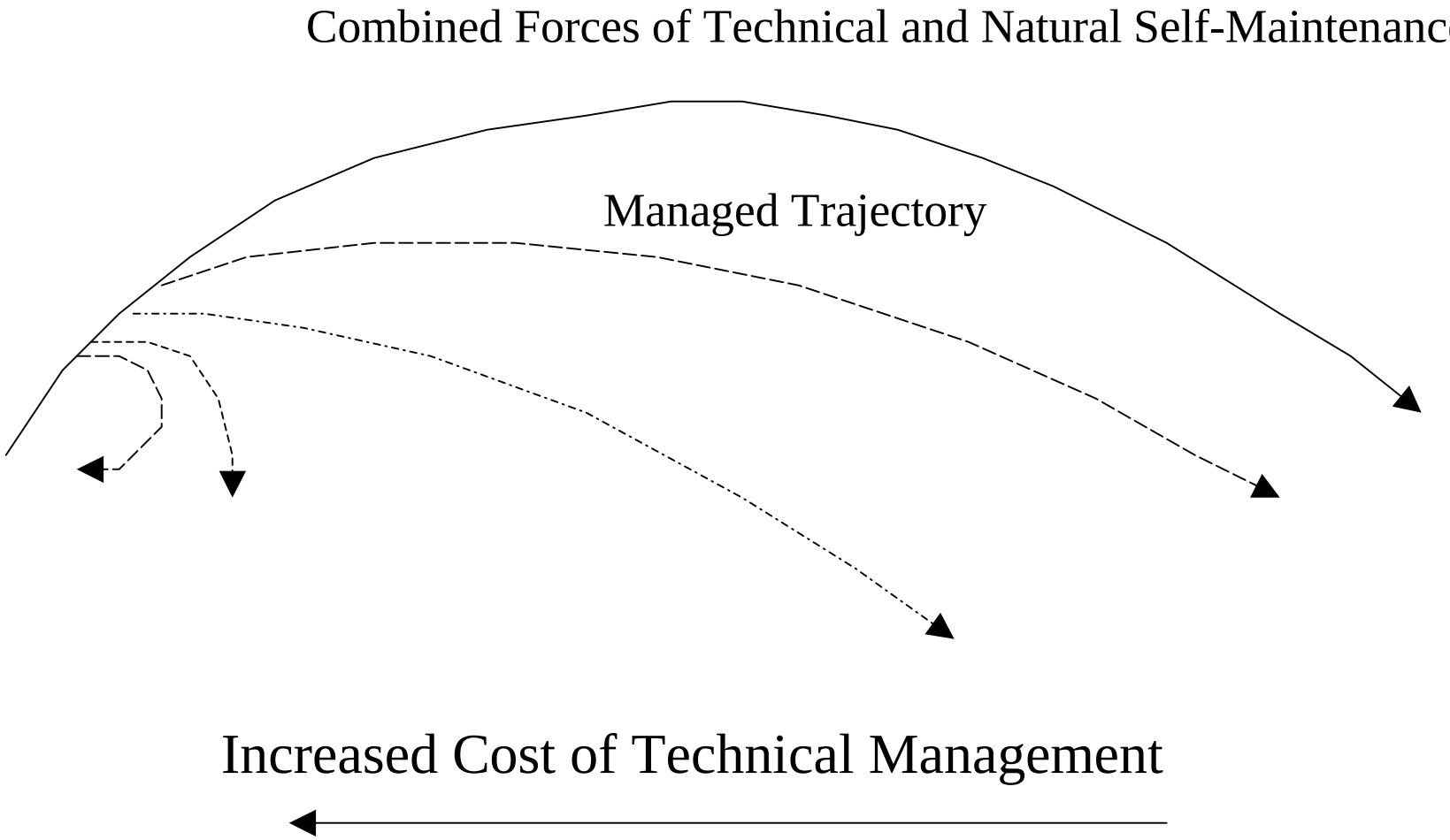
# Natural Ecosystem



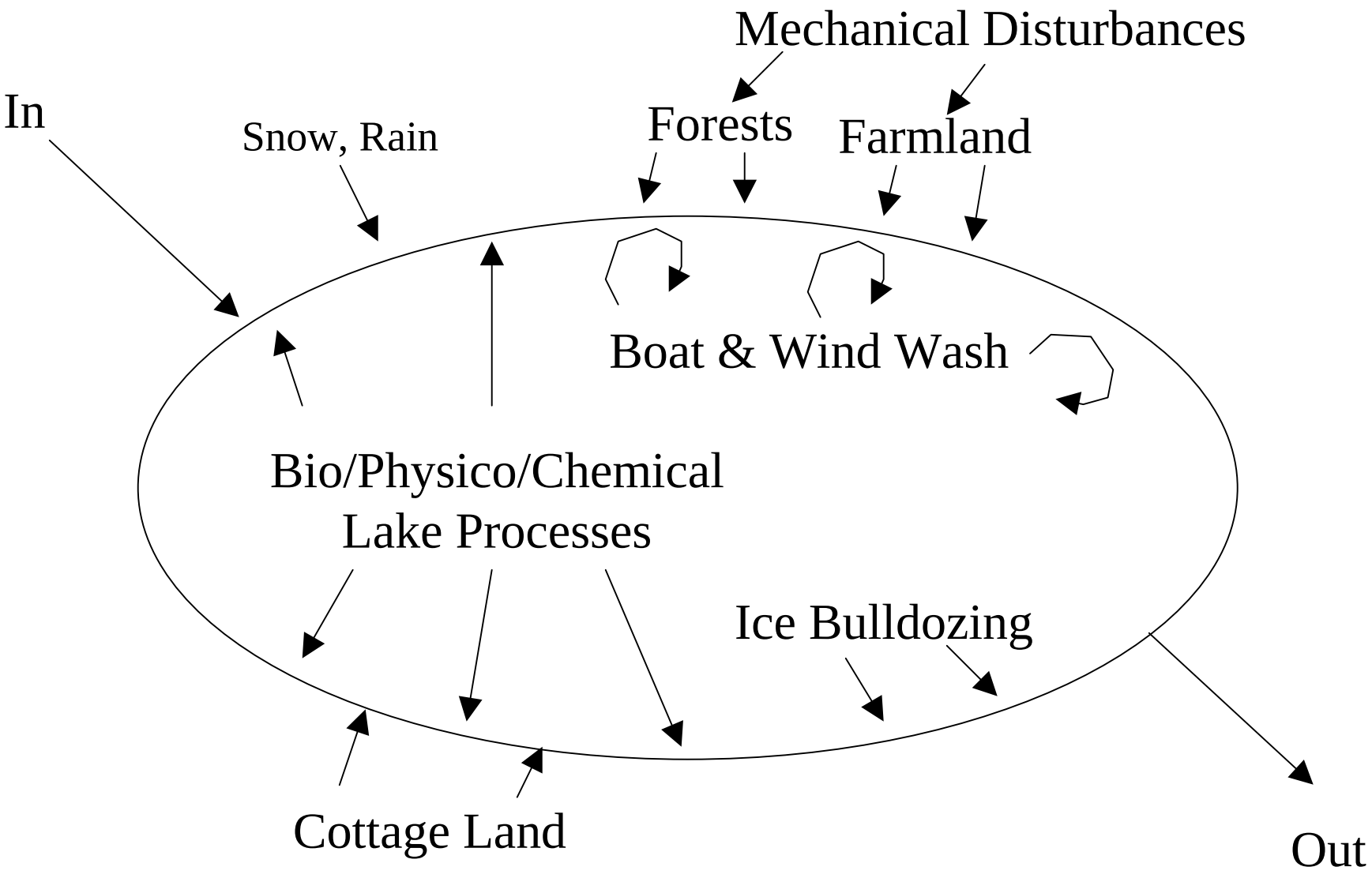
# Impacted Ecosystem



# Managed Ecosystem

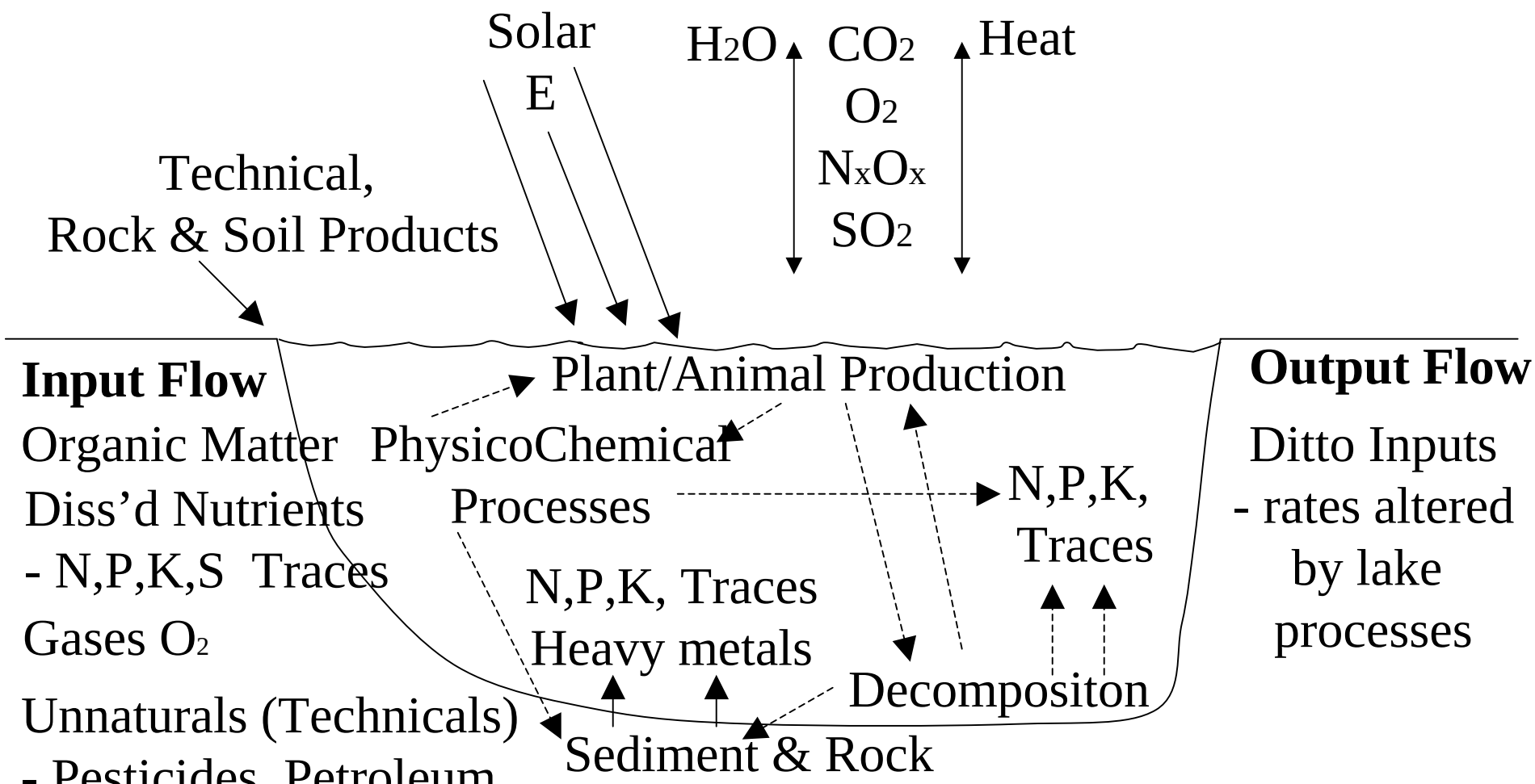


# Kennebec (Cross) Lake



# August conditions

- 1352 Acres
- 35,341 acre feet
- 100 ft max
- 26 ft mean
- 15-30 feet thermocline
- 72 F (22 C) surface
- 42 F (6 C) at 50 ft
- $O_2$ 7 ppm surface
- $O_2$ 2.5 ppm
- Dissolved Solids 65 ppm
- Secchi Diss’d 7.5 ft




**Input Flow**

Organic Matter

Diss'd Nutrients
- N,P,K,S Traces

Gases $O_2$

Unnaturals (Technicals)
- Pesticides, Petroleum, Households

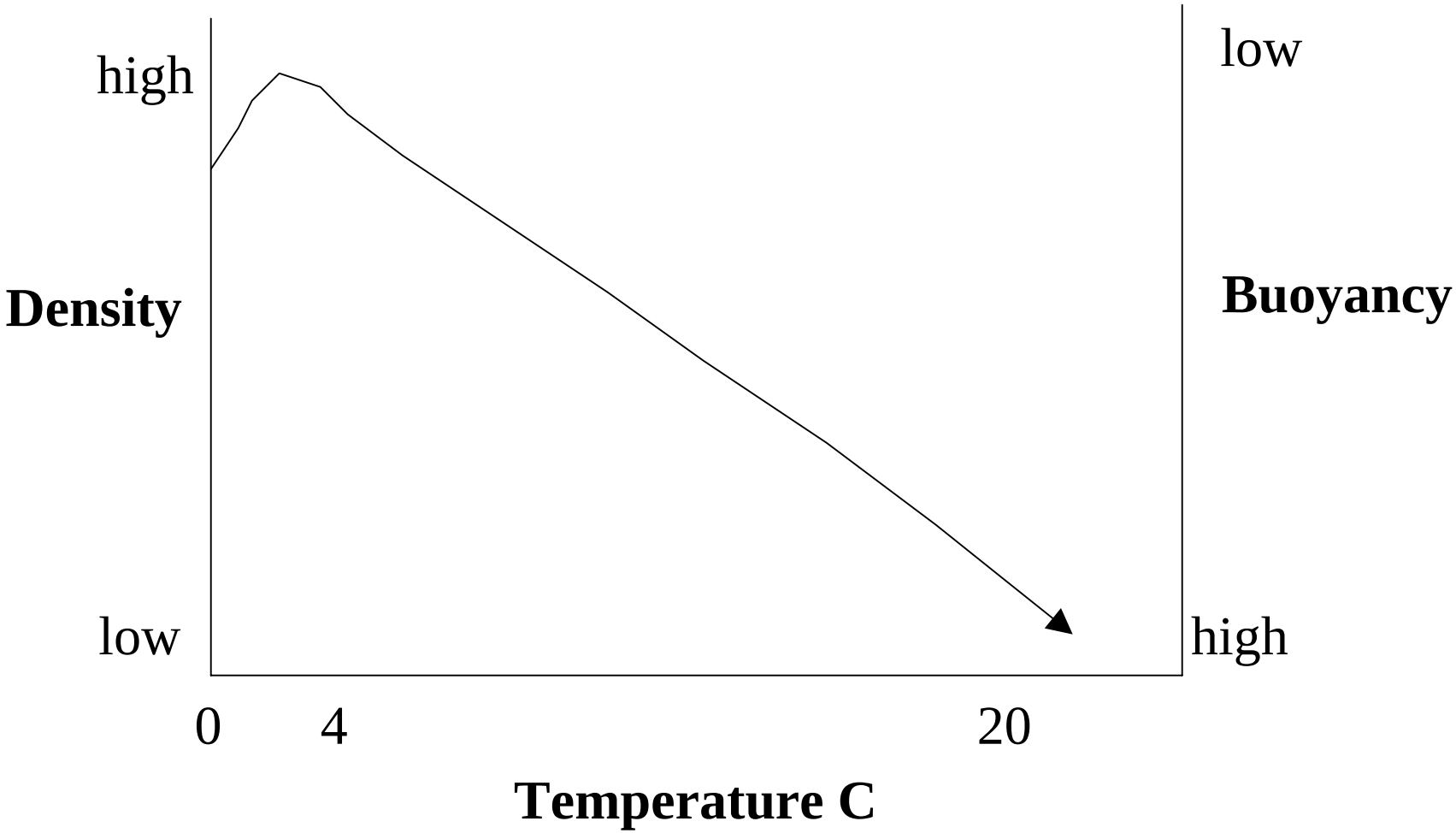
Naturals
- Hg, $Fe_x$ $O_x$

**Output Flow**

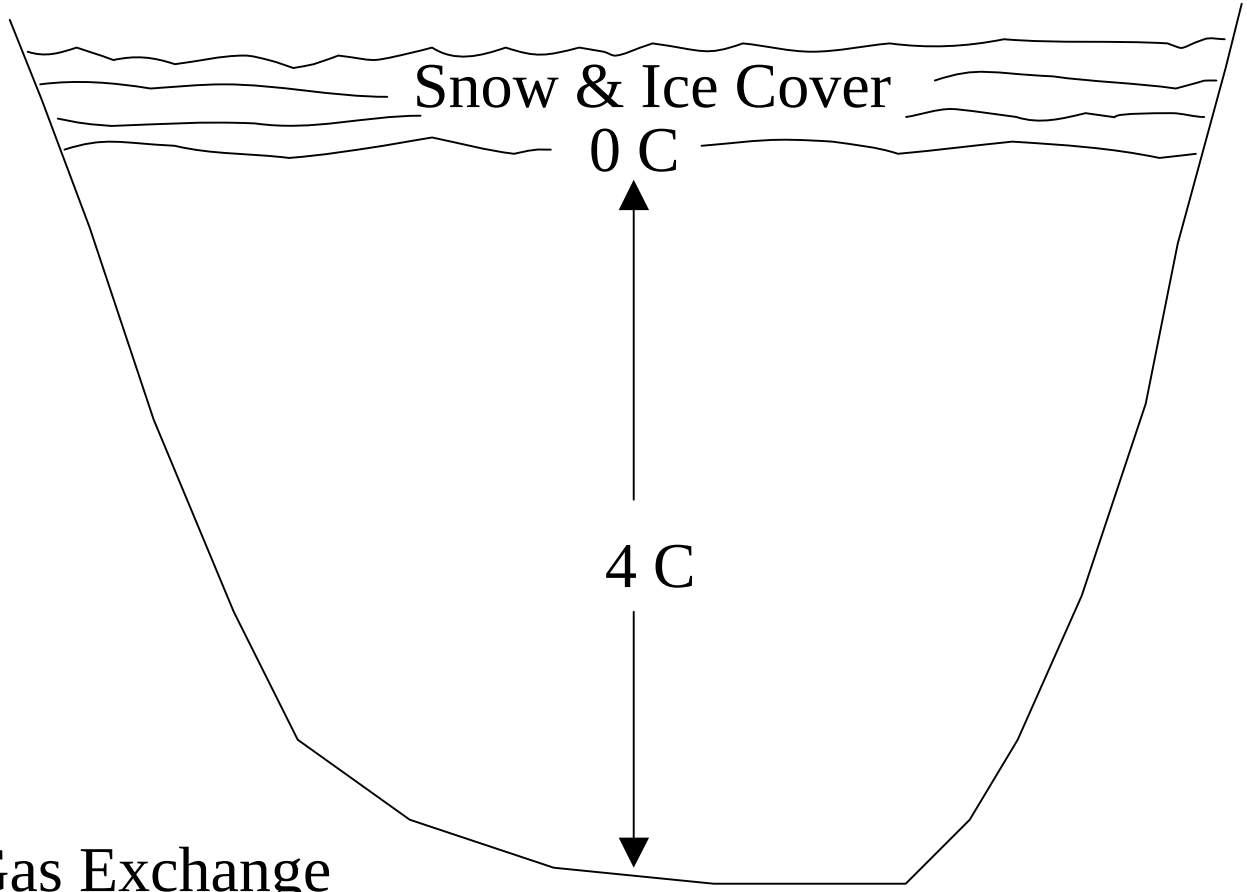
Ditto Inputs
- rates altered by lake processes

**Important Processes**

Photosynthesis → Plant/Animal Production
Decomposition
Exchanges with Atmosphere
Inputs from Rocks, Soils, People


high
low
Density
Buoyancy
low
high
0
4
20
Temperature C

**Winter Lake**



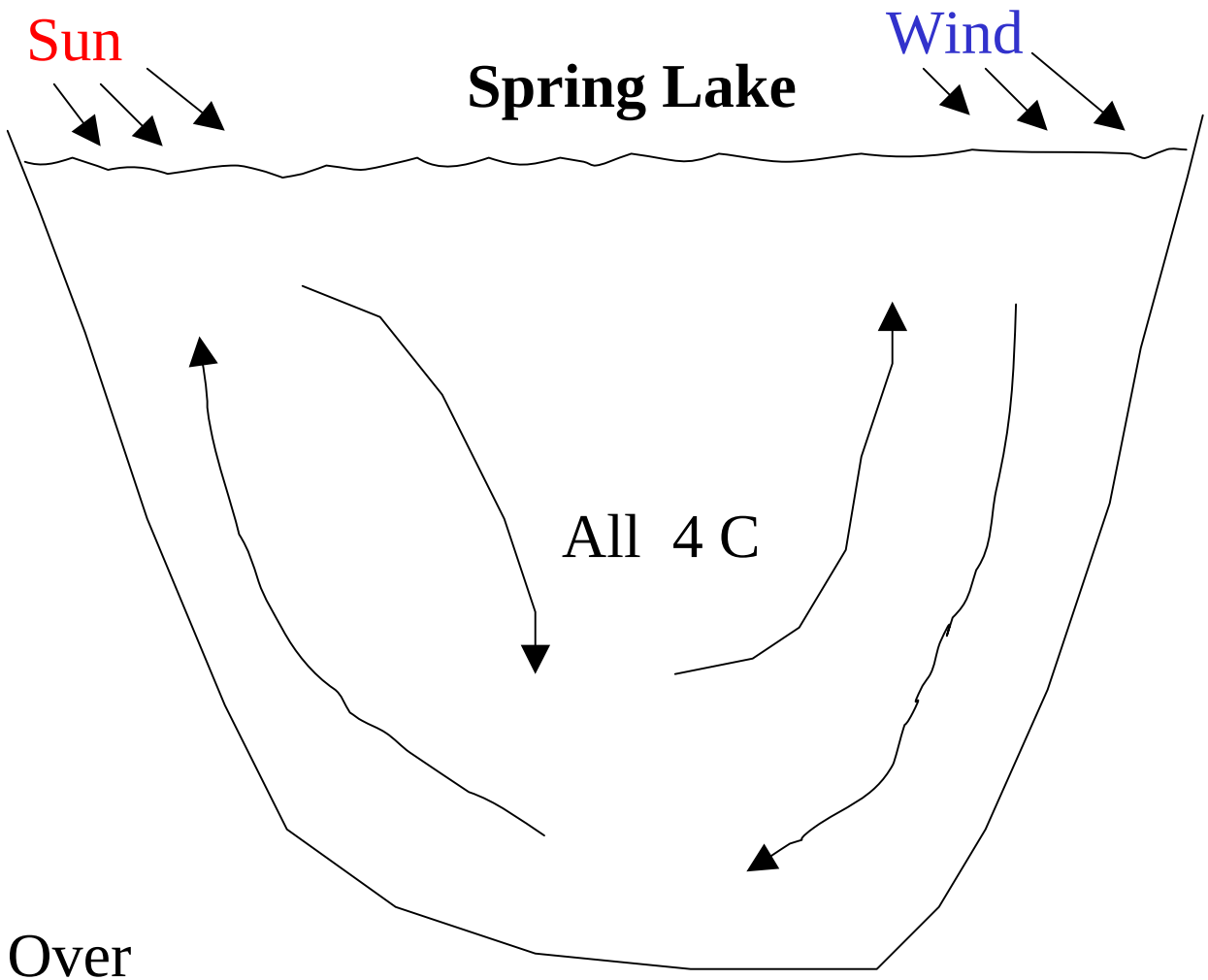

No Gas Exchange

- bottom may be low $O_2$ especially near sediment

Snow blocks lights

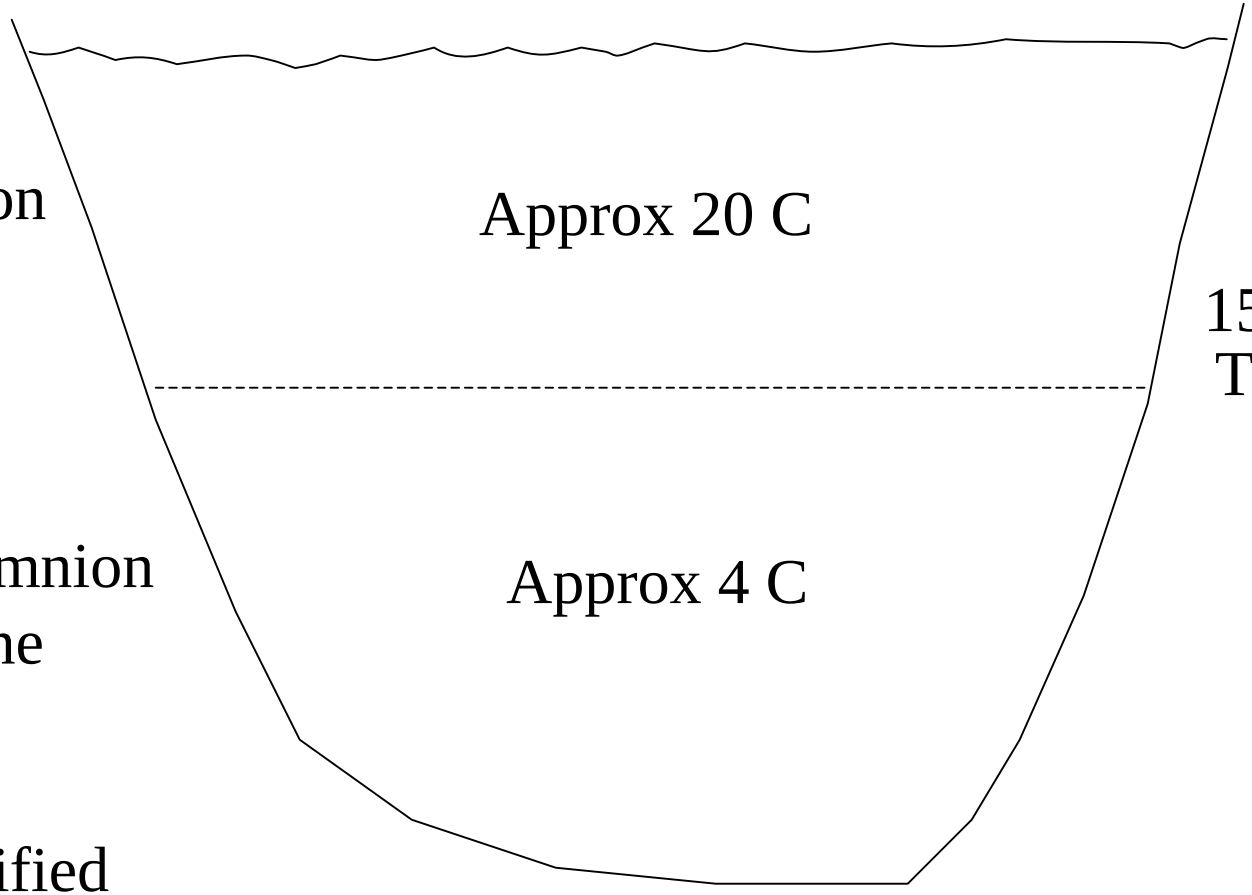
Low temperature slows chemical reactions

Nutrients & Organic Matter settles out




Turn Over
Gases In & Out
Nutrients up from Bottom
Light / Heat Increasing
Algae “Bloom”

**Late Summer Lake**

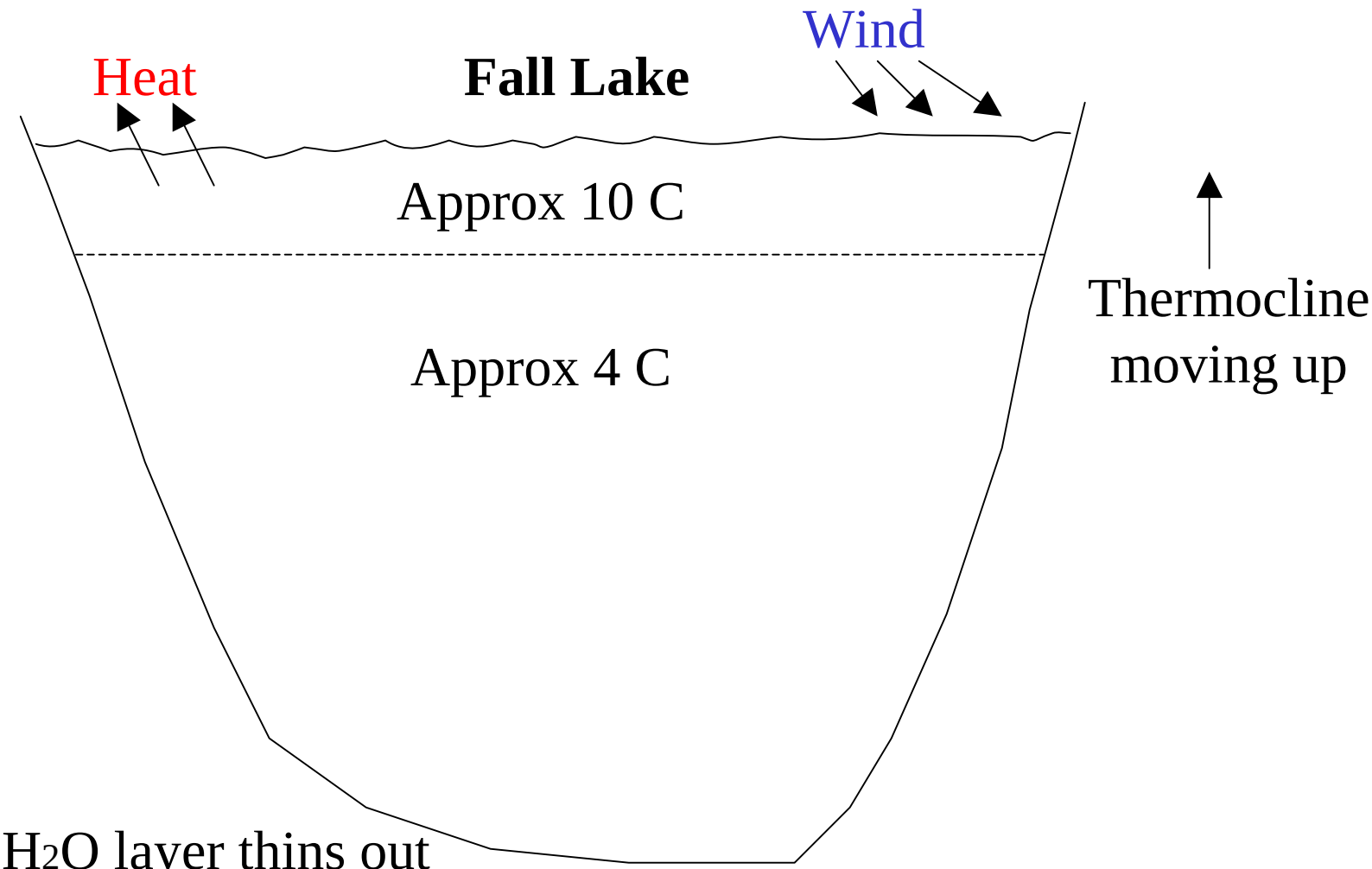



Stratified

No Mixing between top $H_2O$ and bottom $H_2O$

Bottom $H_2O$ low in $O_2$

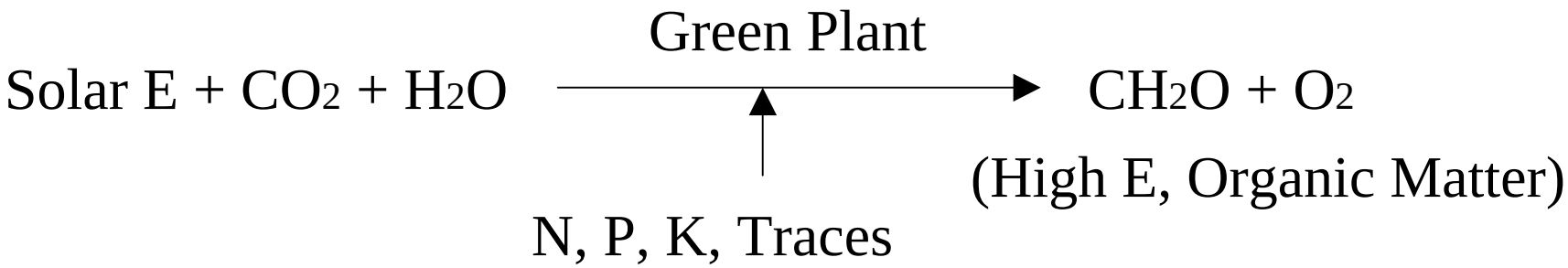
Top Water losing Nutrients & Organic Matter by Settling Out



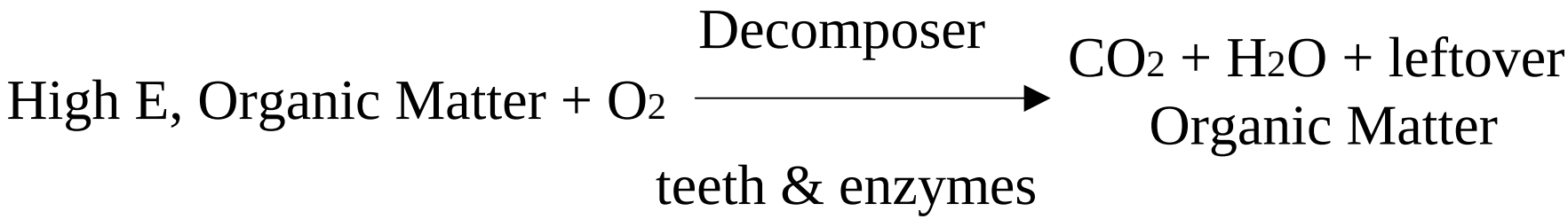

Top $H_2O$ layer thins out
Wind breaks it up
Mixing = Fall Turn Over
May cause another Algal Bloom if top $H_2O$ low in nutrients

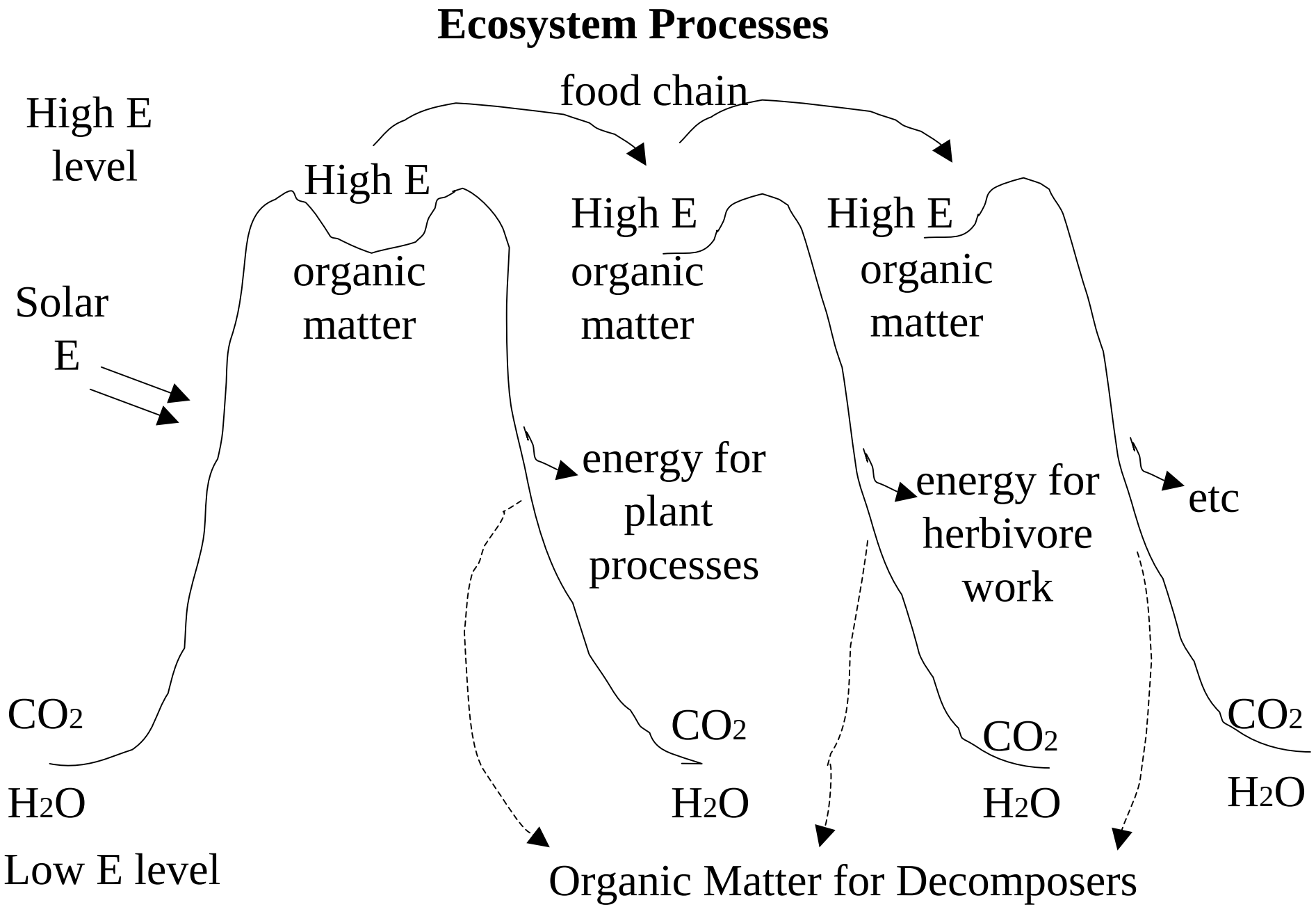
# Bio Processes

- Photosynthesis & Primary “Production”

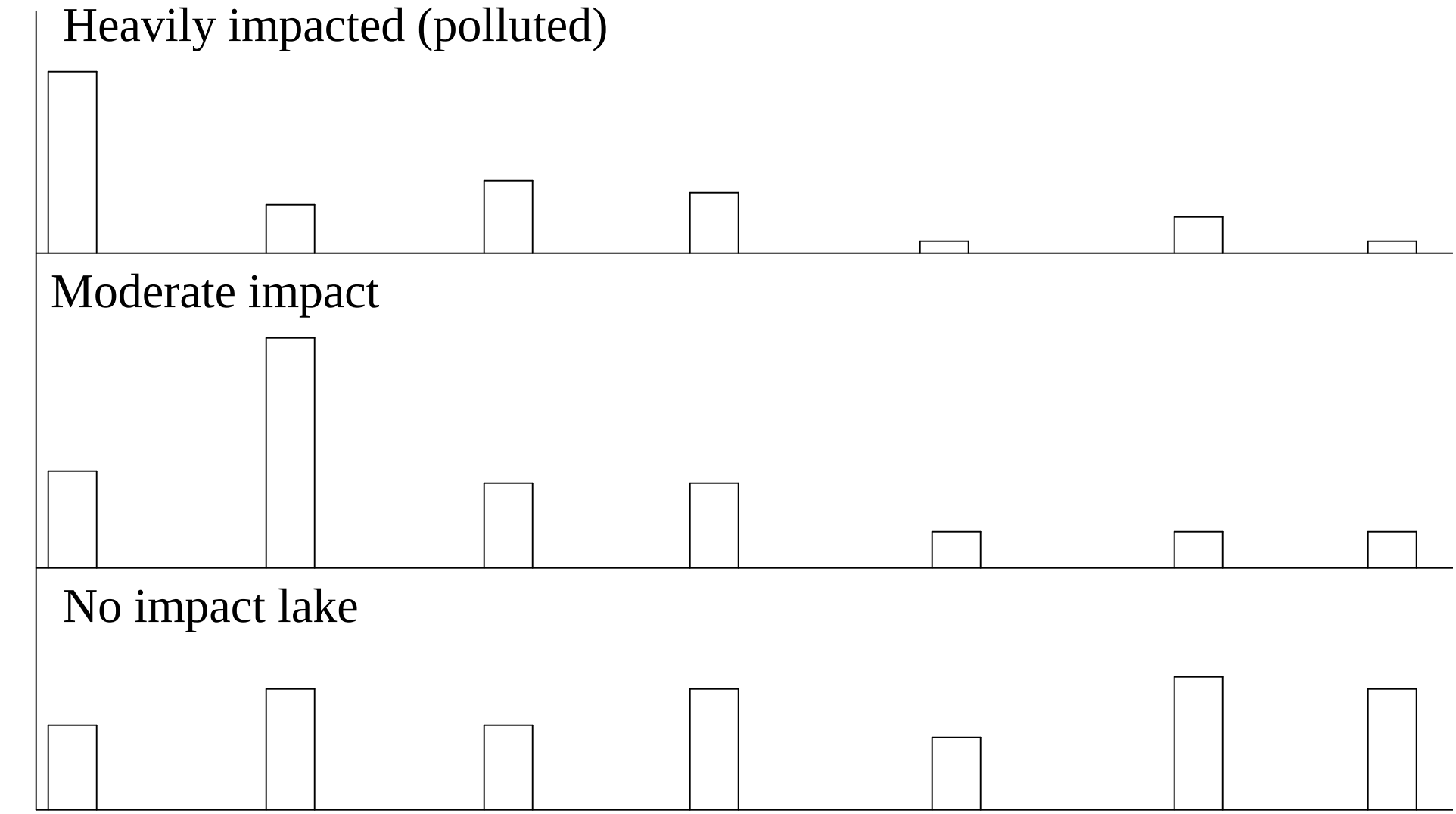



- Decomposition




Ecosystem Processes
food chain
High E level
High E organic matter
High E organic matter
High E organic matter
Solar E
energy for plant processes
energy for herbivore work
etc
CO2
H2O
CO2
H2O
CO2
H2O
CO2
H2O
Low E level
Organic Matter for Decomposers

# Ruth Patrick Indicators



# Ageing (= Overfeeding = Eutrophication)

- Water Flows unchanged
- Lake volume and shape unchanged
- Nutrient Input Increased
  - Sewage Leachate and Grey Water

  (P&N = 1000 x P&N in 'Wild' Lake)

  (x P/Person/Year approx 1.6 kg (3.5lb)

  ( N " " approx 4.5 kg (9.9lb)

# Ageing (cont'd)

- Nutrient Input Increased
  - Raw Mineral Soil Wash (Runoff)
    - Cleared shoreline & lawns
    - Road building / Maintenance
    - Log skidding
    - Farm cultivation
    - Livestock grazing shoreline
  - Abandoned or Destroyed Beaver Ponds
    - Can release 'slug' of nutrient rich water
- Nutrient increase increases primary production
  - Shifts production heavily to Algae

# Ageing (cont'd)

- ↑ 1 P = ↑ Organic Matter Particles
  - Not eaten by herbivores
  - Algae die, particles settle out
  - Extreme: Organic Matter uses up O2 at Night when no O2 produced by algae & fish suffocate
  - Algae + Organic Matter particles increase turbidity drastically (secchi disappears sooner)
- 'Ageing' shifts production to Algae & away from other Aquatic Plants
  - Causes shift in flora and fauna

# Indicators & Indexing

- E.Coli (coliform bacteria) are not indicators of ecological condition of lake
  - Gut bacteria (not just humans)
  - Anaerobes – do not like $O_2$ – do not breed in lake with $O_2$
- E.Coli indicate recently released gut contents (sewage or septic leachate from poor system or wash from barnyard, cows, pigeons etc.)
- E.Coli serves to warn of probability of other pathogens from gut e.g. hepatitus virus
- As indicator of lake conditions, only shows probable mass input of P&N

# Indicators & Indexing

- Alternative: Nitrite ($NO_2$) common only in Septic Outfall
  - Highly unstable in $O_2$, turns to Nitrate ($NO_3$)
  - Therefore If find Nitrite ($NO_2$) you are close to Septic Input
  - Dye in toilet is cheap, easy, direct and isolates the problem.

# Indicators & Tests for Predicting Lake Decline

- Nutrient Levels (P or N)
  - Rising P or N indicates aging soon
    - Predicts so can Prevent (remove the causes not the effects
- Rising Turbidity (Shallower Secchi Readings)
  - Caused by either: Sediment Wash (Soil / Organic Matter) *OR* Algae & Dead Algae
  - If increased Algae (Not seasonal blooms), one step too late to predict decline
  - Secchi study of many lakes over long time useful for provincial trends
  - For Kennebec, need long time (5-10 years) & many locations & if decreasing depth, still one step too late

# Predicting Lake Decline (cont'd)

- E.Coli or Nitrite or Dye Flushes
  - To locate bad septic systems
    - Health concerns
    - Nutrient sources
  - If not fixed, no gain
- Indirect Action vs Responding to Indicators
  - Always act as far back from the lake as possible as long as still draining into it e.g. revegetate shore but also ridges & hills
  - Prevent soil wash in uplands as well as lakeside
  - Prevent beaver pond 'slugs', keep it in the pond

# Remember

Lake Changes
Result Mainly
from
People Activities,
Focus on those Areas