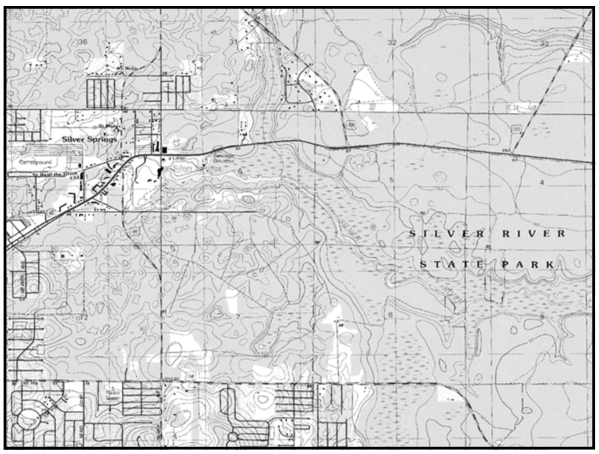
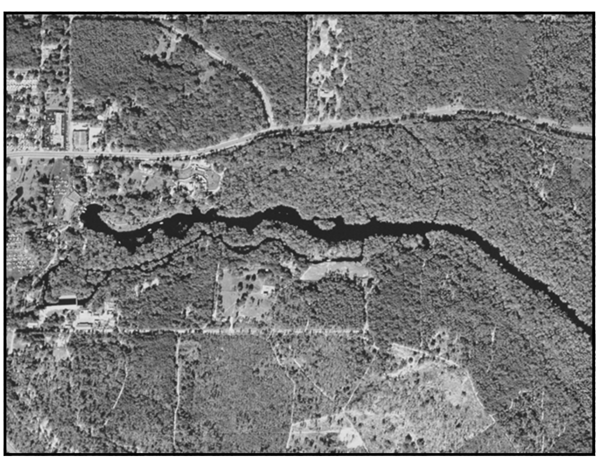
Compartment models cont'd

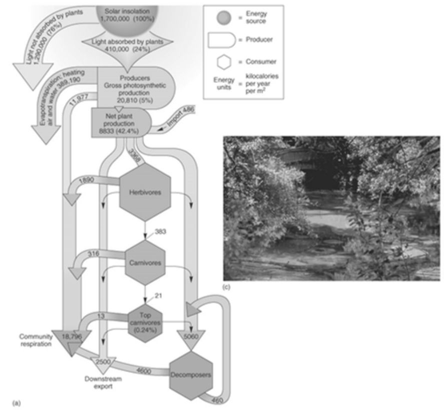
Silver Springs Aquatic System

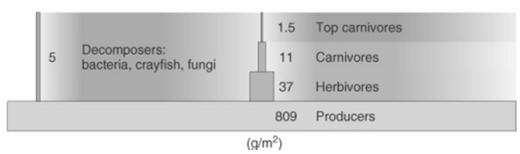
Five sets of organisms

- Primary producers (plants)
- Herbivores (eat plants)
- Carnivores (eat herbivores)
- Top carnivores (eat other carn.)
- Decomposers (consume dead)

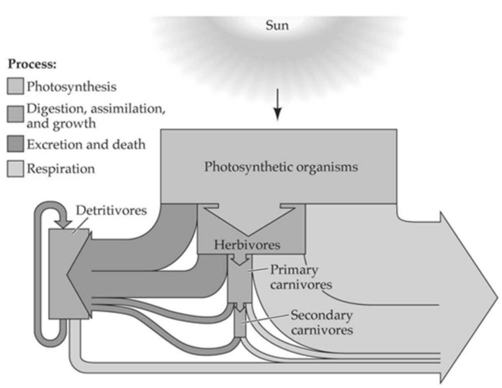


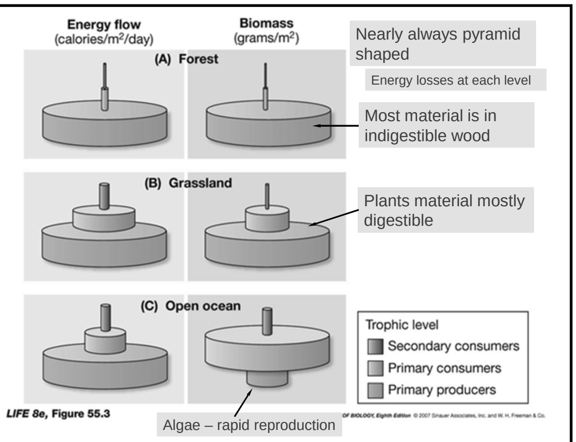




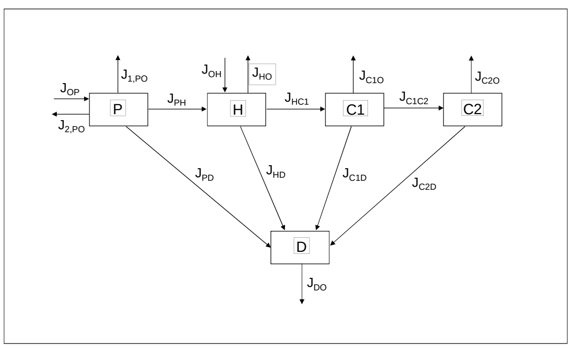


Energy flow – loss due to respiration, excretion, death





Silver Springs Model – the diagram



Compartment Equations

$$\frac{dP}{dt} = J_{OP} - J_{PO} - J_{PH} - J'_{PO} - J_{PD}$$

$$\frac{dH}{dt} = J_{PH} + J_{OH} - J_{HO} - J_{HC1} - J_{HD}$$

$$\frac{dC1}{dt} = J_{HC1} - J_{C1O} - J_{C1C2} - J_{C1D}$$

$$\frac{dC2}{dt} = J_{C1C2} - J_{C2O} - J_{C2D}$$

$$\frac{dD}{dt} = J_{PD} + J_{HD} + J_{C1D} + J_{C2D} + J_{DO}$$

Transfer function examples

$J_{AB} = k$	constant flow
$J_{AB} = k_{AB} A$	donor dependent
$J_{AB} = k_{AB} B$	recipient dependent
$J_{AB} = k_{AB} (A - B)$	donor-recipient difference
$J_{AB} = k_{AB} AB$	donor-recipient product
$J_{AB} = k_{AB} A - l_{AB} A^2$	like logistic function
$J_{AB} = k_{AB} f(t)$	forcing function (time)

Energy inputs

$$J_{OP} = M + R\sin\left(\frac{2\pi(t-11)}{52}\right)$$
$$J_{OH} = k$$

Feeding

$$J_{PH} = a_{PH}\, P\, H$$
$$J_{HC1} = a_{HC1}\, H\, C1$$
$$J_{C1C2} = a_{C1C2}\, C1\, C2$$

Death (decomposition)

$$J_{PD} = b_{PD}\, P$$
$$J_{HD} = b_{HD}\, H$$
$$J_{C1D} = b_{C1D}\, C1$$
$$J_{C2D} = b_{C2D}\, C2$$

Respiration

$$J_{1,PO} = c_{1,PO}\, P$$
$$J_{HO} = c_{HO}\, H$$
$$J_{C1O} = c_{C1O}\, C1$$
$$J_{C2O} = c_{C2O} C2$$
$$J_{DO} = c_{DO}\, D$$

Loss to export

$$J_{2,PO} = e_{PO}\, P$$

Berkeley-Madonna Program

1) Draw compartments
2) Add flows between compartments
3) Define any parameters (like k)
4) Define flows (transfer equations)
5) Set initial conditions
6) Set run options
7) Check compartment DEs
8) Run model (solve)
9) Examine results (draw graphs)