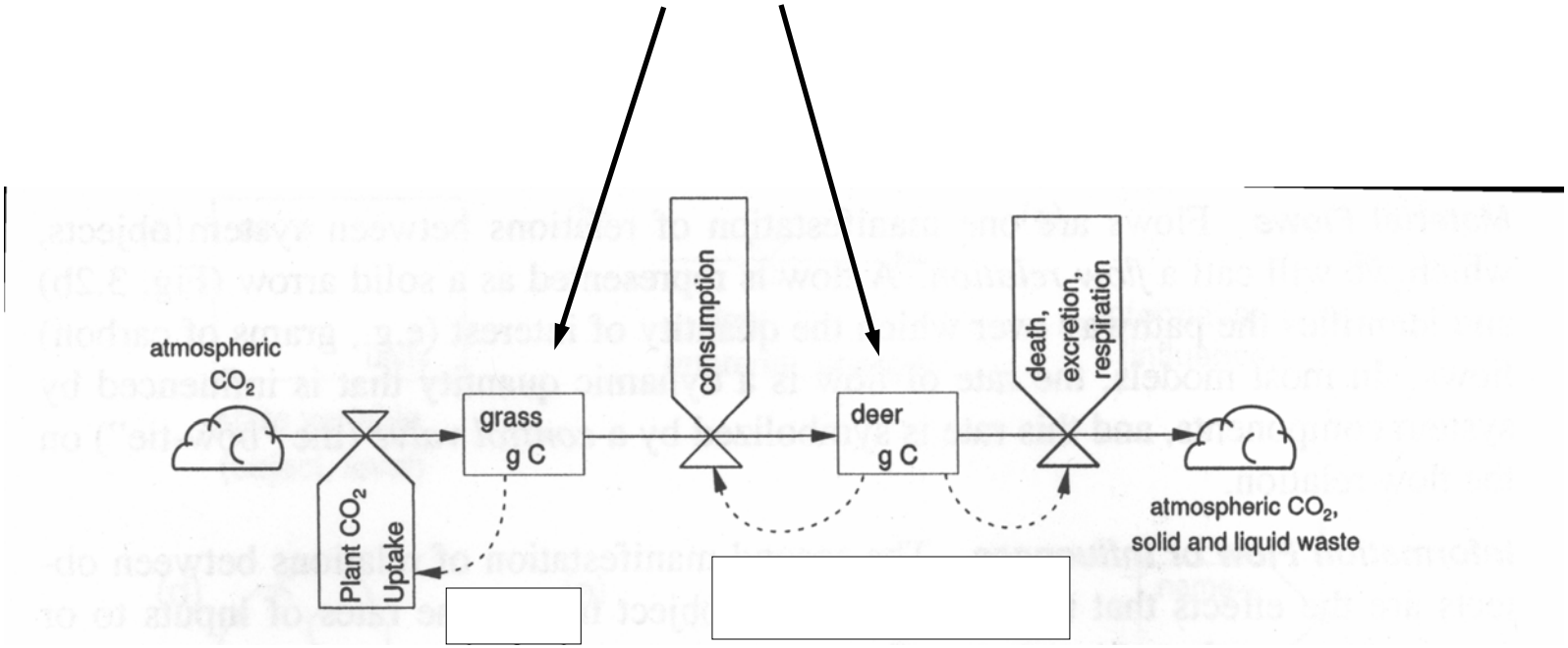
Model development – Qualitative II

Models with multiple state variables (multiple internal objects or compartments)



Purpose: How is profit affected by fertilizer and pesticide use

- Nutrients (N)
- Pests
- Field alfalfa
- Harvest alfalfa

Basic unit for state vars: g / ha

Basic unit for profit: $

Conversion needed !!

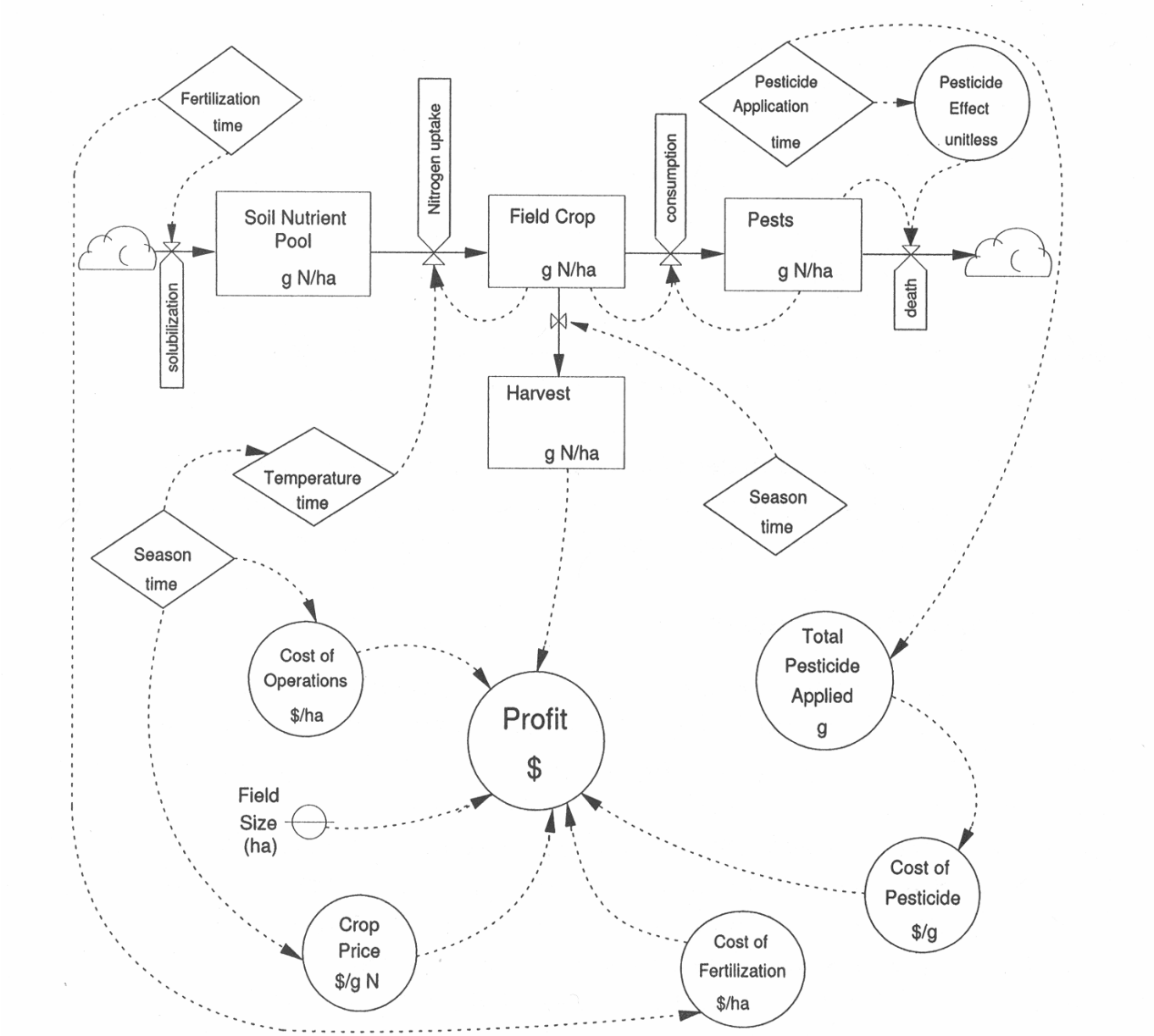
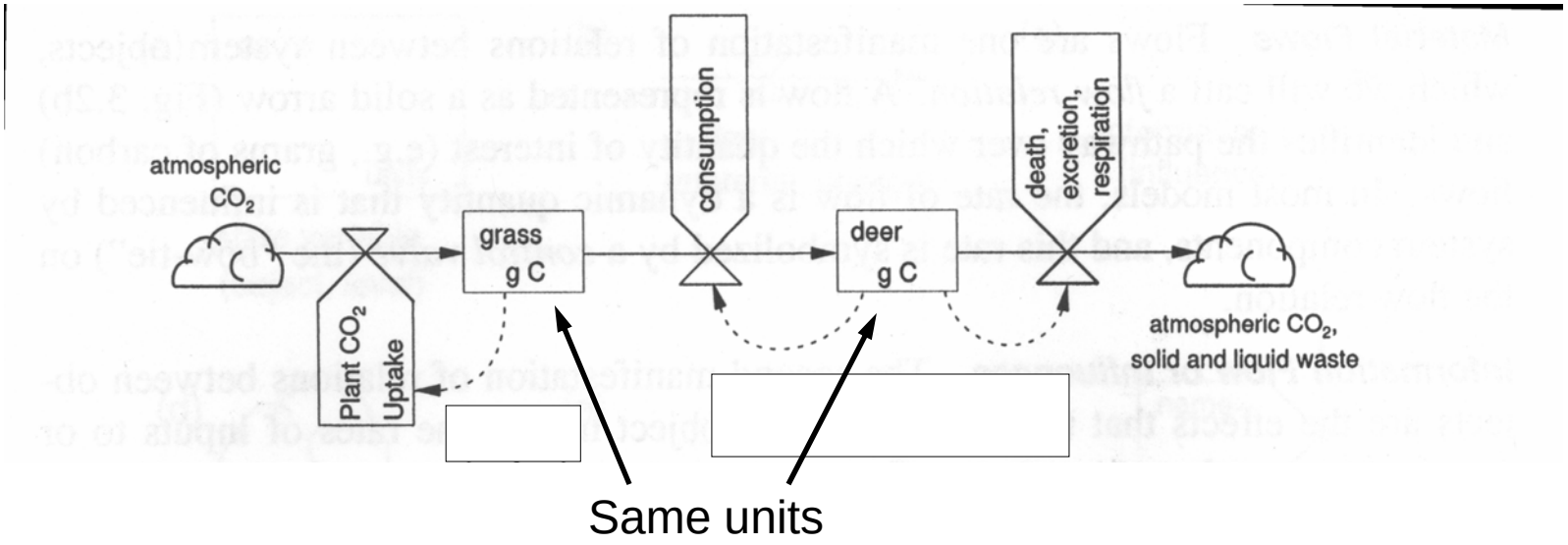


Figure 3.8: Forrester diagram for a hypothetical agroecosystem model showing multiple state variables of an agricultural system.

Units and modeling

Conserved units



Nonconserved units

Number of predators and number of victims – not same units!!

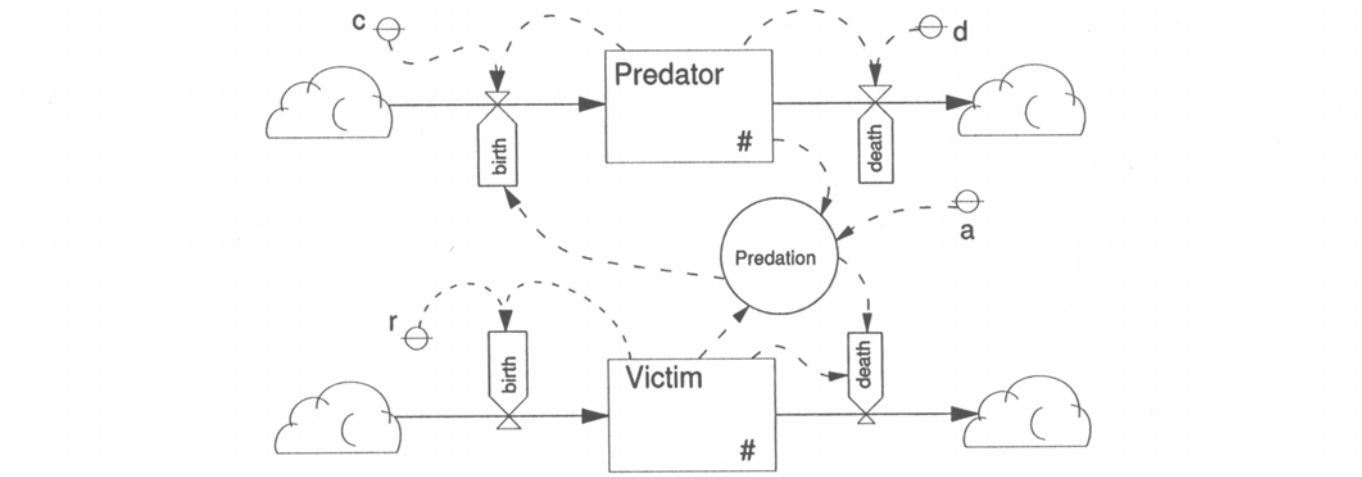


Figure 3.10: Simplified Forrester diagram for linked population models based on numbers of individuals.

Dimensional analysis - units

$$y = a + b$$

units must match

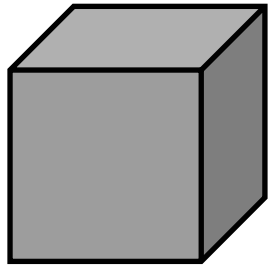
Any equation with physical meaning must be dimensionally consistent

$$density = \frac{mass}{volume}$$

g

g / m^3

m^3



meters

Math operations and units

[x] – means the dimensions of x

Addition, subtraction

$$z = x + y$$

$$[z] = [x] = [y]$$

Can't add apples
and oranges !!

Multiplication

$$z = xy$$

$$[z] = [x][y]$$

$[x] = \text{meters}, [y] = \text{meters}$

$[z] = \text{m}^2$

Division

$$z = \frac{x}{y}$$

$$[z] = [x]/[y]$$

$[x] = \text{grams}, [y] = \text{m}^2$

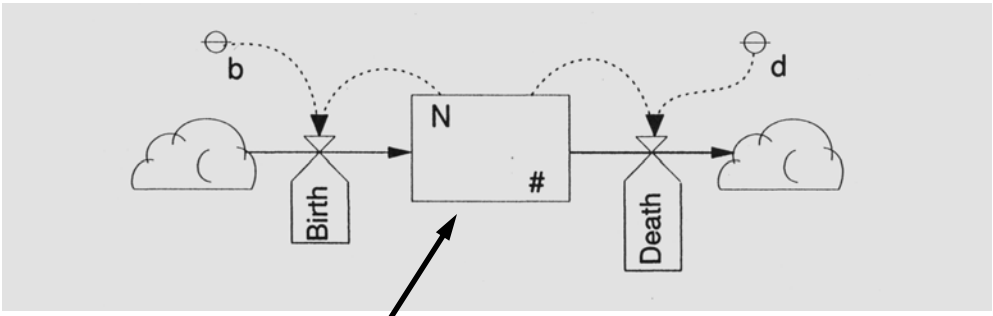
$[z] = \text{g}/\text{m}^2 = \text{g m}^{-2}$

Math formulation is next topic

(Model development – quantitative)

Each state variable (model object, compartment) will have an equation :

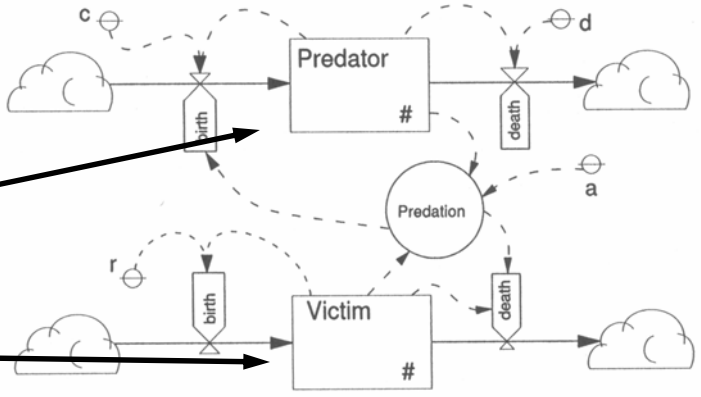
- Describes quantity of material
- Either a FDE or a DE



$$N_{t+1} = N_t + bN_t - dN_t$$

$$P_{t+1} = P_t + abV_tP_t - dP$$

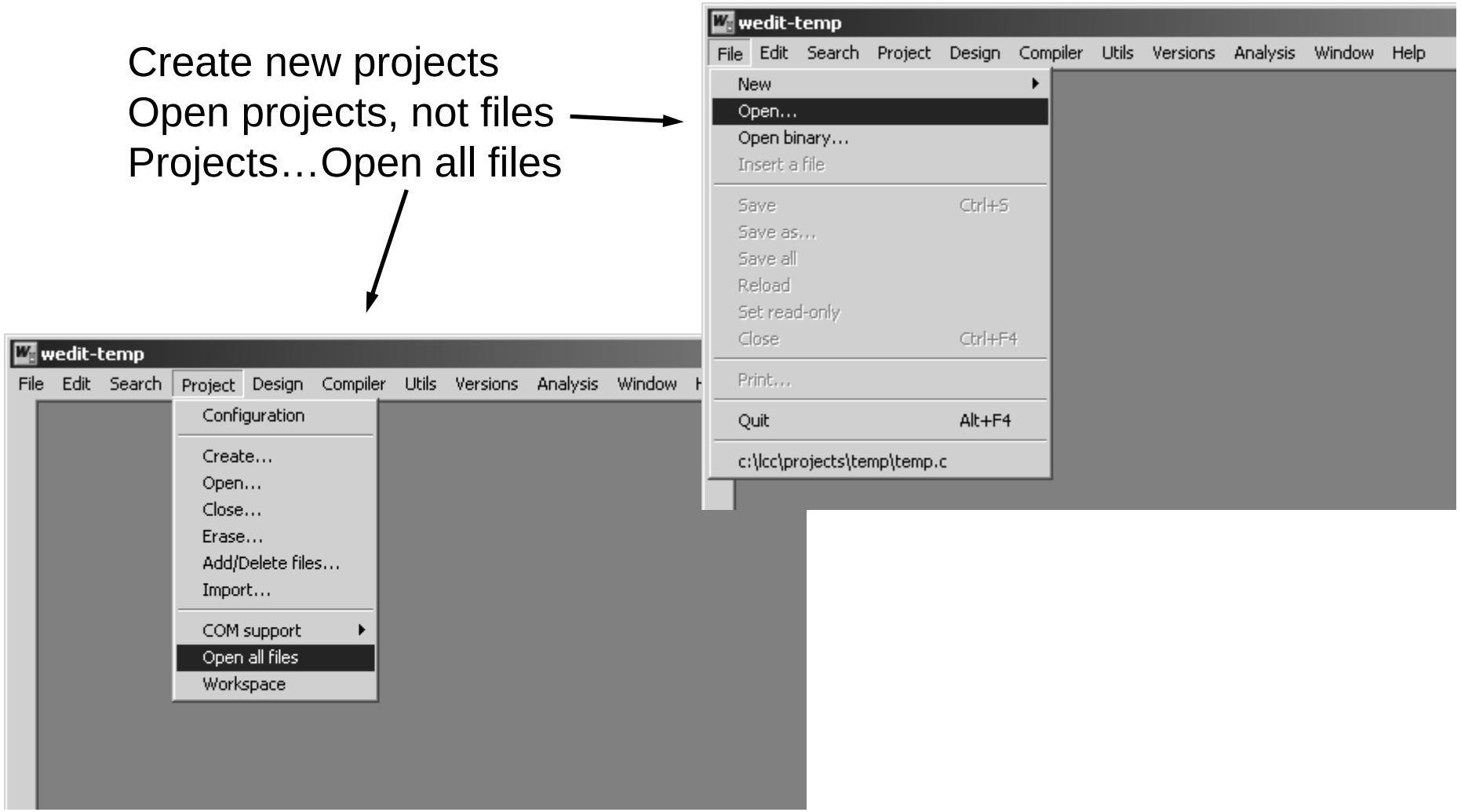
$$V_{t+1} = V_t + rV_t - aV_tP_t$$



Projects and Programming issues…

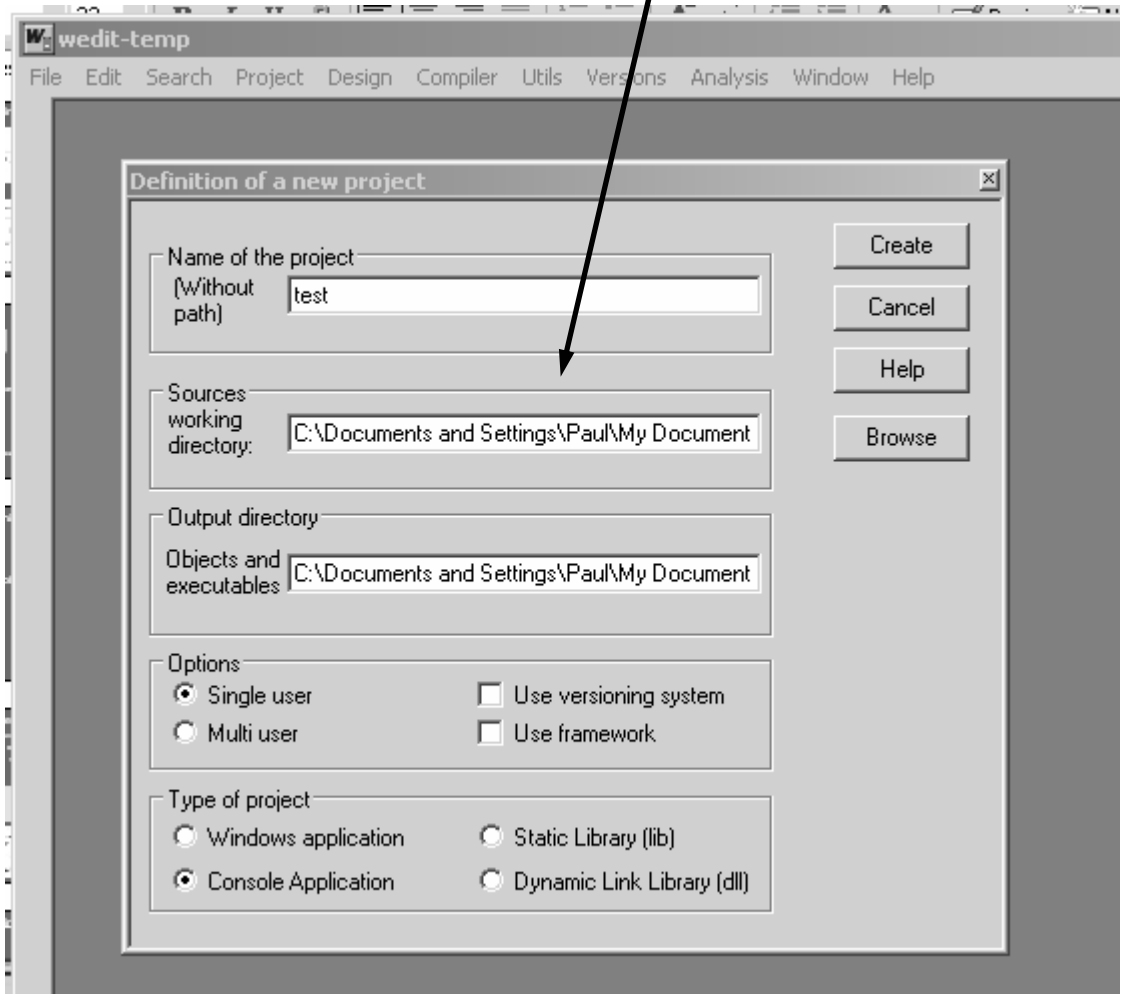
Make sure projects setup right!

Create new projects
Open projects, not files
Projects…Open all files



Project issues cont'd…

No spaces in directory names (not on desktop)



Project reports need graphs…

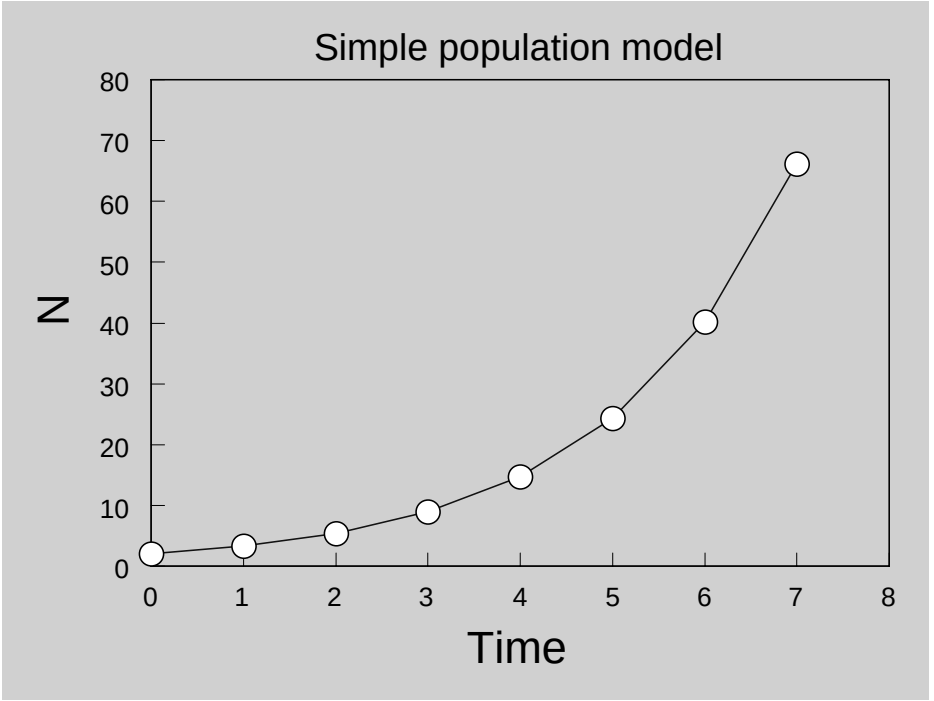
Graphing tutorial – see handout

Most graphs :

- XY scatter plots
- Straight lines connecting points
- Label axes

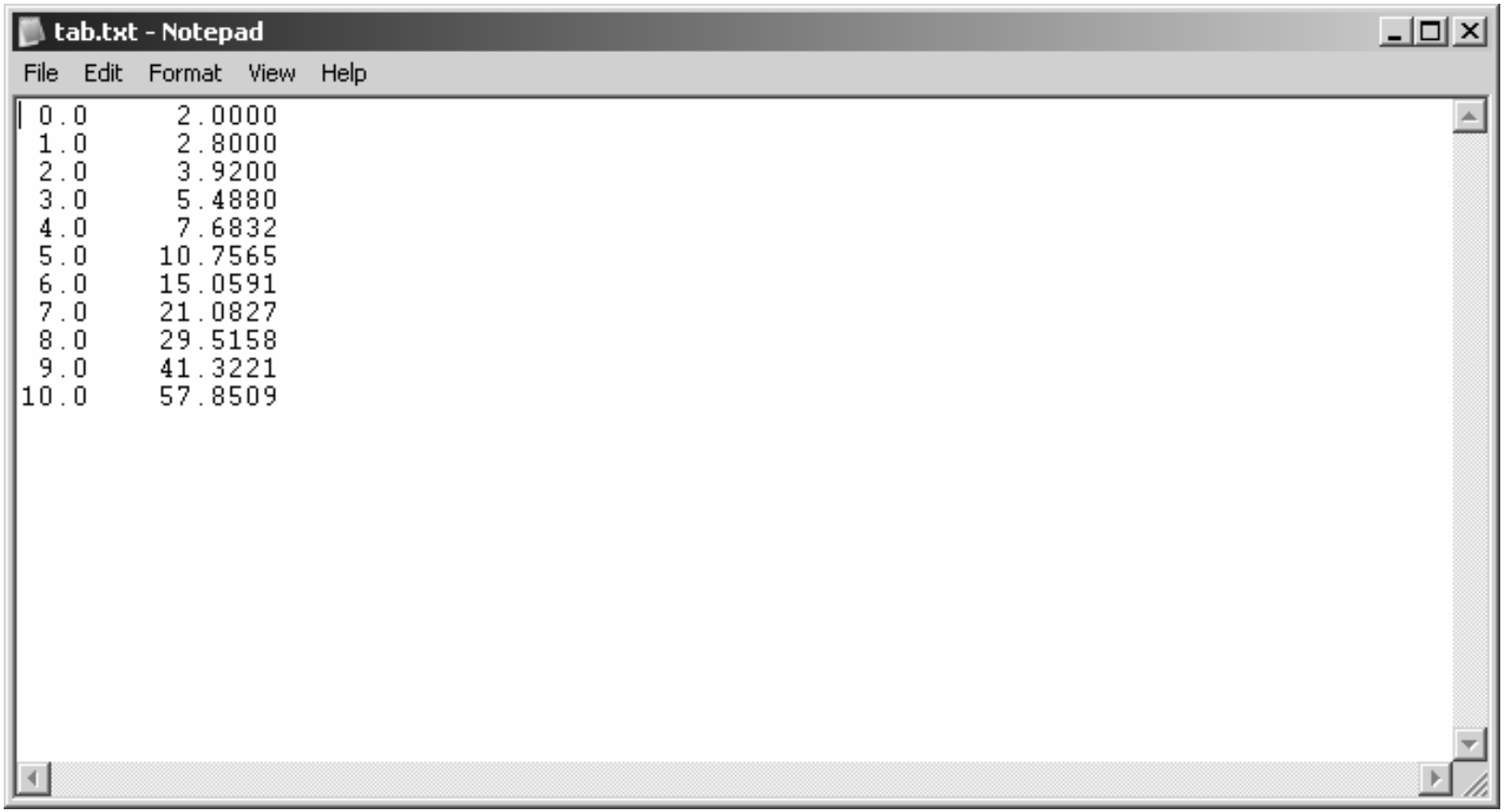
Predator-prey model – plot pred vs prey

Not excel “line” chart



Import data example…

```
for( i=0; i<=steps; i++ )
    {
        fprintf( outfile, "%4.1f\t%7.4f\n", t[i], N[i] );
    }
```



```
for( i=0; i<=steps; i++ )
    {
        fprintf( outfile, "%4.1f, %7.4f\n", t[i], N[i] );
    }
```