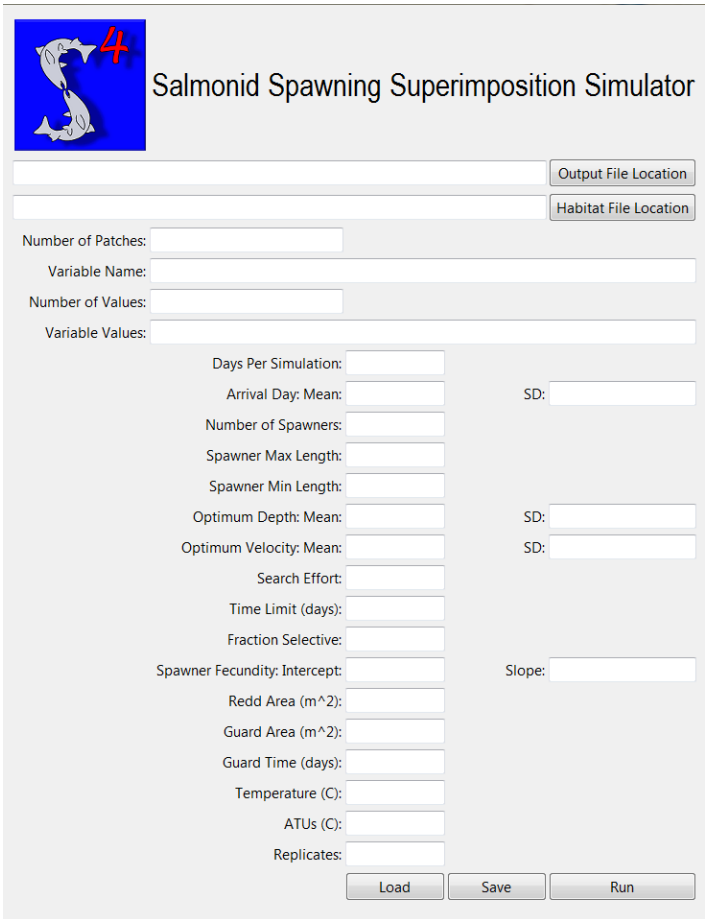
Installing S4

- Go to github.com/pndphd/S4.
- Download the S4.zip file.
- Unpack the file where you wish the program to reside.
- Create a shortcut to the file S4.exe inside the unpacked folder.
- Place that shortcut where you wish to launch the program from.

Running S4

- Launch S4 by clicking on the shortcut you just created.
- You will see the following GUI.



The S4 GUI

- Clicking on the "**Output File Location**" opens an explorer box from which you can pick a folder. The output files will save to that folder.
- Clicking on the "Habitat File Location" opens an explorer box form which you can pick a file.
- The habitat file should be a text file formatted like so:

```
Area 3500 500
Depth 10 15
Velocity 10 15
end
```

- This is the area of each patch separated by spaces, then the depth (m) of each patch separated by spaces and finally the velocity (m/s) of each patch separated by spaces plus "end" at the end. The can be as many patches as the user wants.
- In "**Variable Name**" enter the name of the variable that you wish to change from one run to the next.
    - The options are: Spawner_Length_Mean, Spawner_Length_SD, Arrival_Day_Mean, Arrival_Day_SD, Number_of_Spawners, Temperature, ATUs, Redd_Area, Time_Limit, Guard_Time, Spawner_Fecundity_Intercept, Spawner_Fecundity_Slope, Guard_Area, Search_Effort, and Replicates, Fraction_Selective.
    - Enter only one of these.
    - Enter it exactly as written here (i.e. no spaces, use underscores).
- In "**Number of Values**" enter an integer equal to the number of variable values you are going to have the model run over.
- In "**Variable Values**" enter the values of the variables you want to model to run over
    - Separate the variables with one space (no commas, semicolons or other separators)
- In "**Days Per Simulation**" enter the number of days over which you wish to run the simulation.
- In "**Arrival Day: Mean**" enter the day as an integer. This is the day during the simulation when the most spawners will enter the system. Spawners enter the system according to a normal distribution; this is the mean of the distribution
- In "**Arrival Day: SD**" enter the standard deviation of the distribution of spawner arrival times. Spawners enter the system according to a normal distribution; this is the standard deviation of the distribution.
    - Depending on the values of "**Days Per Simulation**," "**Arrival Day: Mean**" and "**Arrival Day: SD**" the simulation may create a fish that is scheduled to enter the system before day one. If this happenes, that fish will enter on day one. Excess number of these may affect your simulation and you should considering changing some of the above mentioned three parameters.
- In "**Number of Spawners**" enter the total numbers of female spawners that will enter the system.
- In "**Spawner_Start_Length (m):**" enter mean length of all the spawners entering at the beginning of the spawning window.
- In "**Spawner_End_Length (m):**" enter mean length of all the spawners entering at the end of the spawning window.
- In "**Search Effort**" enter the number of times per day a spawner will attempt to find a location to spawn.
- In "**Time Limit (days)**" enter the number of days after which a spawner, if they have not yet spawned successfully, will die and their eggs will be considered unspawned.
- In "**Fraction Selective**" enter the fraction (as a decimal) of spawners you wish to be selective. These spawners will only spawn on an already established redd (assuming at least one redd has been established).
- In "**Spawners Fecundity: Intercept**" enter the value you want for a in the following equation.

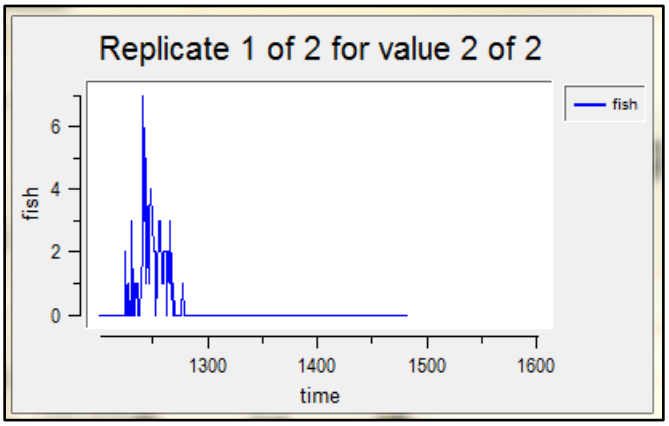
$$N = aL^b$$

  N is that number of eggs, L is the fork length of the spawner in meters.
- In "**Spawners Fecundity: Slope**" enter the value you want for b in the previous equation.
- In "**Redd Area (m^2)**" enter the amount of area a redd occupies. The program treats redds as circles.
- In "**Guard Area (m^2)**" enter the area around the redd a spawner will guard after spawning.
- In "**Guard Time (days)**" enter the number of days a spawner guards a redd.
- In "**Temperature (C)**" enter the temperature of the environment in degrees Celsius.
- In "**ATUs (C)**" enter the number of accumulated thermal units in degrees Celsius that an eggs needs to hatch.
- In "**Replicates**" enter the number of runs you wish to average over for each variable value.

- You can load previously constructed input files by clicking "**Load**". This will open an explorer window where you can select that file you wish to load.
- You can save you input file for later reloading by clicking "**Save**". This will open an explorer window where you can select a location for the file and give it a name.
- Click "**Run**" to run the program.
- Once you click "**Run**" you will see the following panel.

The default swarm control panel

- Click "**Start**" to start the simulations.



The simulation tracking panel

- The top of the panel states the number total number of variable values, the number of replicates per value, which replicate the simulation is on, and which value the simulation is on. For example "**Replicate 1 of 2 for value 3 of 4**" would mean that you had asked the simulation to run over four values and it is currently on the third. For each value, you requested two replicates and the simulation is currently on the first for this value.
- Once all values and replicates are completed, the simulation tracking panel and swarm control panel will automatically close.

S[4] Outputs

- There will be three output files
    - runlog.txt
    - Output.csv
    - OutputSummary.csv
- runlog.txt is simply a log of what is happening as the program runs and details on some types of errors
- Output.csv is a daily output for each value and replicate. It gives that day of the run, the cumulative number of redds, the cumulative number superimposed redds, the number of spawners currently guarding, the cumulative number of unspawned eggs, the cumulative number of killed eggs, the cumulative number of hatched eggs and the fraction of eggs killed.
- OutputSummary.csv is a summary output for each value averaged over all replicates for that value. It gives the total days run each run, the total number of redds, the total number superimposed redds, the number of spawners currently guarding, the total number of unspawned eggs, the total number of killed eggs, the total number of hatched eggs and the fraction of eggs killed.